TESIS DOCTORAL / DOCTORAL THESIS

Programa de Doctorado

Enfermería Clínica y Comunitaria.

Title

Indirect and/or remote methodology in hospital and community nursing care.

Título

Metodología indirecta y/o a distancia en los cuidados de enfermería en atención hospitalaria y primaria.

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Julio Emilio Marco Franco

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Facultad de enfermería. Universidad de Oporto

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DEDICATORIA

A mis nietas Sofia y Claudia

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PUBLICACIONES

1. │Marco-Franco, J.E., Reis-Santos, M., Barrachina-Martínez, I., González-de-Julián, S., & Camaño-Puig, R. (2022). *Validation of a new telenursing questionnaire : Testing the test*. ***Mathematics,*** 10(2463), 1–13. https://doi.org/10.3390/math10142463

2. │Marco-Franco, J.E., Reis-Santos, M., Barrachina -Martinez, I., Jurewicz, A., & Camaño-Puig, R. (2023). *Telenursing: The view of care professionals in selected EU countries. A pilot study*, ***Heliyon,*** Volume 9, Issue 6, e16760. ISSN 2405-8440. https://doi.org/10.1016/j.heliyon.2023.e16760.

3. │ Marco-Franco, J.E., Reis-Santos, M., González-de-Julián, S., Mikla M., & Camaño-Puig, R. (2023). *Remote assessment of the work environment through bibliometric analysis. The example of nursing in the pandemic.* En proceso de publicación.

4.│Marco-Franco J.E., Reis-Santos, M., Barrachina-Martínez, I. and Camaño-Puig, R. *Further validation by Rasch analysis of Telenursing questionnaire.* En proceso de publicación.

5.│Marco-Franco J.E., Reis-Santos, M., and Camaño-Puig, R. *Telenursing: Lessons from three decades of publications.* En proceso de publicación.

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ABBREVIATIONS

ANOVA	Analysis of variance
AP	Atención Primaria
CI	Confidence Interval
CTT	Classical Test Theory
Dffcit	A measure of difficulty in Rasch analysis
DOI	Digital Object Identifier
Dscm	A measure of discrimination in Rasch analysis
EAP	Expected a Posteriori (reliability ratio)
EU	European Union
ICC	Item Characteristic Curve (Rasch)
ICNM	International Centre on Nursing Migration
ICT	Information and Communications Technology
IIC	Item Information Curve (Rasch)
Infit	Inlier-sensitive or information-weighted fit
IoT	Internet of Things
IRT	Item Response Theory
KMO	Kaiser-Meyer-Olkin test
Logit	Binary choice model, based on a standard logistic cumulative distribution
LR	Likelihood ratio (Andersen)
MNSQ	Mean-square or standardized fit statistics (t)
Outfit	Outlier-sensitive weighted fit
PHC	Primary Health Care
TAM	Technology Acceptance Models
WHO	World Health Organization
WLE	Warm's Mean Weighted Likelihood Estimates

RESUMEN

Esta tesis se ha configurado como secciones independientes para poder ser publicadas posteriormente de forma individual. En la primera sección se acomete el estado del arte de la teleenfermería con una revisión de todas las publicaciones encontradas con la palabra teleenfermería en el título. El análisis de las publicaciones permite conocer los países con más producción científica, las orientaciones de los trabajos y otros datos de interés, e incluye un mapa coroplético. Las siguientes tres secciones forman una tríada de trabajos estructurados para obtener la perspectiva del personal de enfermería sobre la teleenfermería. Aunque se han realizado algunos estudios sobre aspectos parciales, y también desde el punto de vista del paciente, hasta la fecha no se había publicado una evaluación general de la opinión de los profesionales de enfermería. El primer trabajo de esta tríada presenta un nuevo cuestionario con 18 preguntas emparejadas (para evitar preguntas capciosas) en escala Likert−5 y tres preguntas dicotómicas, una por dominio, que analizan los dominios de utilidad, aceptación y adecuación de la teleenfermería en la enfermería clínica. Una vez diseñado el cuestionario, se generaron por ordenador seis bases de datos con diferentes tipos de simetría y curtosis, así como diferente índice de concordancia entre los pares de preguntas, para cubrir todas las posibilidades teóricas de respuesta. Los resultados se analizaron mediante el método clásico (CTT) y la teoría de respuesta al ítem (Rasch). Se obtuvieron alfas de Cronbach entre 0,80−0,95, Kaiser-Meyer-Olkin entre 0,93−0,92 y la prueba de esfericidad de Bartlett resultó altamente significativa (p<0,0001). El análisis Rasch mostró un coeficiente de fiabilidad (EAP) de 0,94, una estimación de probabilidad media ponderada de Warm (WLE)

de 0,94 y valores extremos infit-t y outfit-t de +1,61, –1,98. El siguiente documento de la tríada, muestra los resultados de la encuesta en tres países seleccionados de la UE con distintos perfiles económicos (España, Portugal, Polonia), utilizando el cuestionario validado en la fase anterior. Se encuestaron 225 enfermeros/as trabajando en atención primaria, especializada o residencias de ancianos. Los resultados mostraron la adecuación del modelo también en la práctica, para la medición de los dominios de utilidad, aceptación y adecuación de la teleenfermería (alfa global de Cronbach 0,945, Kaiser-Meyer-Olkin 0,952 y *p* de Bartlett <0,001). Las respuestas favorables a la teleenfermería obtuvieron una puntuación promedio de 4 sobre 5 en la escala de Likert, tanto globalmente como en los tres dominios. La estimación promedio de uso de teleenfermería de un 34.3% indica que el personal de enfermería considera que su profesión requiere una actividad fundamentalmente presencial. En el análisis ANOVA, los resultados de Portugal fueron significativamente superiores a los de España y Polonia, tanto a nivel global como para cada una de las dimensiones. Tras transformar los datos politómicos en dicotómicos se realizó un análisis más exhaustivo con metodología Rasch, incluyendo los infit y outfit estandarizados, la dificultad de los ítems, y estadísticas de bondad de ajuste. Se obtuvo un coeficiente de fiabilidad (EAP) de 0,825, y la estimación de la probabilidad media ponderada de Warm fue de 0,715. El análisis de Rasch confirma los resultados obtenidos anteriormente utilizando CTT. El cuestionario es válido, aunque quizás la pregunta cuatro debería reformularse para mejorar la coherencia de las respuestas o suprimirse con o sin su par (pregunta cinco).

Finalmente, en la última sección se presenta un quinto trabajo de metodología a distancia para valorar la utilidad del procedimiento bibliométrico. La epidemia de COVID-19 representó una

oportunidad para analizar el clima laboral del personal de enfermería antes, durante y después del brote principal de la pandemia a través de sus publicaciones.

Se seleccionó una muestra (*n* = 828) de la producción cuatrienal de artículos científicos de enfermería (2019 a 2022) para analizar los temas: 1/ protección personal; 2/ alteraciones psicológicas; 3/ procedimientos; y 4/ gestión, en los ámbitos de atención primaria, hospitalaria y residencias geriátricas. Se aplicó metodología no paramétrica para determinar las variaciones de tendencias en el tiempo, que resultaron ser estadísticamente significativas. Los datos reflejaron cambios principalmente en temas de salud mental y gestión, pero las diferentes áreas (atención primaria, hospital y residencias de ancianos) siguieron sus propios patrones. El procedimiento demostró que el método a distancia bibliométrico es sensible a la detección de cambios del ambiente laboral, abriendo la puerta a otros usos, con distintos temas y publicaciones o presentaciones en congresos.

La metodología a distancia puede contribuir a que la realización del trabajo de enfermería sea más eficiente, y ayudar a paliar la creciente escasez de profesionales de enfermería.

RESUM

Aquesta tesi s'ha configurat com a seccions independents per a poder ser publicades posteriorment de manera individual. En la primera secció s'escomet l'estat de l'art de la teleinfermería amb una revisió de totes les publicacions trobades amb la paraula teleinfermería en el títol. L'anàlisi de les publicacions permet conéixer els països amb més producció científica, les orientacions dels treballs, i altres dades d'interés, i inclou un mapa coroplètic.

Les tres seccions següents formen una tríada d'articles estructurats per a obtindre la perspectiva del personal d'infermeria sobre la teleinfermería. Encara que s'han realitzat alguns estudis sobre aspectes parcials, i també des del punt de vista del pacient, fins hui no s'ha publicat una avaluació general de l'opinió dels professionals d'infermeria. El primer treball d'aquesta tríada presenta un nou qüestionari amb 18 preguntes aparellades (per evitar preguntes capcioses) amb una escala Likert−5, i tres preguntes dicotòmiques, una per domini, que analitzen els dominis d'utilitat, acceptació i adequació de la teleinfermeria al camp clínic. Una vegada dissenyat el qüestionari es van generar per ordinador sis bases de dades amb diferents tipus de simetria i curtosi, així com diferent índex de concordança entre les preguntes, per cobrir totes les possibilitats teòriques de resposta. Els resultats es van analitzar mitjançant el mètode clàssic (CTT) i la teoria de resposta a l'ítem (Rasch). Es van obtindre alfes de Cronbach entre 0,80−0,95, Kiser-Meyer-Olkin entre 0,93−0,92 i el test d'esfericitat de Bartlett va resultar altament significatiu p<0,0001. En l'anàlisi de Rasch, es va obtindre un coeficient de fiabilitat (EAP) de 0,94, amb estimació de probabilitat mitjana ponderada de Warm (WLE) de 0,94, i valors extrems infit-t i outfit-t de +1,61, –1,98. El següent document de la tríada, mostra els resultats de l'enquesta en tres països seleccionats de la UE amb diferents perfils econòmics (Espanya, Portugal, Polònia), utilitzant el qüestionari validat en la fase anterior. Es van enquestar 225 infermers/as treballant en atenció primària, especialitzada o residències d'ancians. Els resultats van mostrar l'adequació del model també a la pràctica per mesurar els dominis d'utilitat, acceptabilitat i adequació de la teleinfermeria (alfa de Cronbach global 0,945, Kaiser-Meyer-Olkin 0,952 i Bartlett p<0,001). Les respostes favorables a la teleinfermeria van obtindre una puntuació mitjana de 4 sobre 5 en l'escala de Likert, tant

globalment com pels tres àmbits. L'estimació mitjana d'ús de teleinfermería d'un 34.3% indica que el personal d'infermeria considera que la seua professió requereix una activitat fonamentalment presencial. En l'anàlisi ANOVA, els resultats de Portugal van ser significativament superiors als d'Espanya i Polònia, tant en l'ambit global com per a cadascuna de les dimensions. Després de transformar les dades politòmiques en dicotòmics es va realitzar una anàlisi més exhaustiva amb la metodologia Rasch, incloent-hi els infit i outfit estandarditzats, la dificultat dels ítems, i estadístiques de bondat d'ajust. Va resultar un coeficient de fiabilitat (EAP) de 0,825. L'estimació de la probabilitat mitjana ponderada de Warm va ser de 0,715. L'anàlisi de Rasch confirma els resultats obtinguts anteriorment utilitzant CTT. El qüestionari és vàlid, encara que la pregunta quatre tal vegada podría re formular-se per a millorar la coherència de les respostes o suprimir-se amb am el seu parell o sense (pregunta cinc). Finalment, en l'última secció es presenta un cinqué treball de metodologia a distància per a valorar la utilitat del procediment bibliomètric. L'epidèmia de COVID-19 va representar una oportunitat per a analitzar el clima laboral del personal d'infermeria abans, durant i després del brot principal de la pandèmia a través de les seues publicacions. Es va seleccionar una mostra (*n* = 828) de la producció quadriennal d'articles científics d'infermeria (2019 a 2022) per a analitzar els temes: 1/ protecció personal; 2/ alteracions psicològiques; 3/ procediments; i 4/ gestió, en els àmbits d'atenció primària, hospitalari i residències geriàtriques. Es va aplicar metodologia no paramètrica per a valorar els canvis de tendència en el temps que van resultar estadísticament significatives. Les dades van reflectir canvis principalment en temes de salut mental i gestió, però les diferents àrees (atenció primària, hospital i residències geriàtriques) van seguir els seus propis patrons. El

procediment va demostrar que el mètode bibliomètric a distància és sensible a la detecció de canvis de l'ambient laboral, obrint la porta a altres usos, amb diferents temes i publicacions o presentacions a congressos.
La metodologia a distància pot contribuir a fer que la realització del treball de l'infermer siga més eficient, i contribuir a pal·liar la creixent escassetat de professionals d'infermeria.

SUMMARY

This thesis has been configured as self-standing sections in order to be published independently at a later date. The first section deals with the state of the art of telenursing with a review of all the publications found with the word telenursing in the title. The analysis of the publications allows us to know the countries with the highest scientific production, the focus on the papers, and other data of interest, including a choropleth map. The following three sections form a triad of papers structured to elicit nurses' perspectives on telenursing. Although some studies have been carried out on partial aspects, and also from the patient's point of view, a general evaluation of the opinion of nursing professionals has not been published to date. The first paper of this triad presents a new questionnaire with 18 paired questions (to avoid leading questions) on a Likert−5 scale, and three dichotomous questions, one per domain, analysing the domains of usefulness, acceptance, and appropriateness of telenursing for nursing clinicians. Once the questionnaire was designed, six databases were computer-generated with different types of symmetry and kurtosis, as well as different matching rates between questions, to cover all theoretical response possibilities. The results were analysed using the

classical method (CTT) and item response theory (Rasch). Cronbach's alphas ranged from 0.80 to 0.95, Kaiser–Meyer–Olkin (KMO) (0.93 to 0.95) and a significant p <0.0001 for Bartlett's test of sphericity were obtained. Rasch analysis showed reliability coefficient (EAP) of 0.94. Warm's mean-weighted likelihood estimate (WLE) of 0.94. Extreme infit-t and outfit-t values obtained were +1.61, –1.98. The next paper of the triad presents the results of the survey administered in three selected EU countries with different economic profiles (Spain, Portugal, Poland), using the questionnaire as validated in the previous phase. A total of 225 nurses were surveyed working in primary care, specialised care, or nursing homes. The results showed the suitability of the model also in practice for the measurement of the domains of usefulness, acceptability, and appropriateness of telenursing (overall Cronbach's alpha 0.945, Kaiser-Meyer-Olkin 0.952 and Bartlett's p <0.001). Responses in favour of telenursing scored an average of 4 out of 5 on the Likert scale, both overall and for the three domains. It is remarkable that the estimated average use of telenursing is 34.3%, indicating that nurses consider their profession to be mainly face-to-face. In the ANOVA analysis, the results for Portugal were significantly higher than those for Spain and Poland, both overall and for each of the dimensions. After transforming the polytomous data into dichotomous data, further analysis was performed using Rasch methodology, including standardised infit and outfit, item difficulty, and goodness-of-fit statistics. The reliability coefficient (EAP) was 0.825. Warm's mean weighted likelihood estimate was 0.715. The Rasch analysis confirms that the questionnaire is valid, although perhaps question four should be rephrased to improve the consistency of responses or deleted with or without its pair (question five). Finally, a last section with a fifth work on remote methodology research was conducted to assess the usefulness of

the bibliometric procedure. The COVID-19 epidemic represented an opportunity to analyse the labour climate of nursing staff before, during and after the main outbreak of the pandemic through the publications of nursing professionals. A sample (n = 828) of the four-year production of nursing scientific articles (2019 to 2022) was selected to analyse the topics: 1/ personal protection; 2/ psychological alterations; 3/ procedures; and 4/ management, in primary care, hospital and nursing home settings. Non-parametric methodology was applied to determine changes of trends over time that were statistically significant. The data reflected changes mainly in mental health and management issues, but the different areas (primary care, hospital, and nursing homes) followed their own patterns. The procedure demonstrated that the bibliometric distance method is sensitive to detecting changes in the labour environment, opening the door to other uses, with different topics and different publications or conference presentations.

Remote methodology can contribute to making the performance of nursing work more efficient and help to alleviate the growing shortage of nursing professionals.

1. ‖ FOREWORD

The format of this thesis may seem unusual, but it is the result of reconciling different regulations. Firstly, the international mention for the doctorate requires, according to Royal Decree 576/2023 (art. 15), a number of conditions:

- To have carried out a stay of at least three months in a foreign research centre, authorised by the academic committee. This involves writing a research project in a foreign scientific language.

- Two expert reviewers (who cannot have been the tutors at the foreign centre where the research was carried out) must report positively that the thesis deserves such international recognition. Logically, this again requires that the text in its entirety can be understood by these experts.

- There must be an expert from a non-Spanish centre on the examining board, who logically must also be able to understand the full text of the thesis.

- The thesis must be written and defended, at least in its conclusions and summary, in a scientific language other than the official languages of Spain.

The coincidence of all these conditions means that the theses that opt for the international mention usually end up being written entirely in English.

However, in this case, i.e., when a foreign scientific language is used, the University of Valencia regulations require that the doctoral thesis must include a comprehensive summary written in one of the official languages of the University of Valencia, which must include

the objectives, methodology and conclusions of the thesis, with a maximum length of 8000 words.

In this research it was intended to opt for the thesis modality by published papers, a modality that requires the presentation of a minimum of three articles, already published or accepted in journals indexed in an international index such as JCR (WoS) and/or SJR (Scopus). In this case, the format of the thesis changes again according to the rules, since it must be accompanied by an overall summary of the subject matter, the main results, and conclusions, justifying the author's original contribution, written in any of the official languages, with a minimum of 4000 words.

When the thesis was already largely structured and written, with two articles published in first-rate journals, a problem arose with the third article. Several attempts to submit the work were answered, after a long wait, with the surprising reply that no expert reviewers could be found, and this represented a hiatus of almost a year. The deadline for submission of the thesis was getting dangerously close, and although two more articles were generated, there were serious doubts that they would be accepted in time, especially as there were not many journals with an agreement with the University of Valencia to avoid paying article processing charges (APC).

Given the uncertainty as to whether or not the thesis could be submitted as for published papers, a mixed format of separate sections with their own references, common in other disciplines, has finally been chosen to ensure that, whether or not a third paper is accepted in time, the thesis can be submitted on time. This means that the references do not all appear only at the end, but also in the sections, corresponding to the articles. Those at the end correspond to the general comments that encompass all the papers.

2. ‖ INTRODUCTION

The digital transformation has represented a true revolution to the point that society is already talking about a new digital era (Dreyer et al., 2006) in a world that is increasingly globally connected. This, hopefully, can lead to international cooperation to solve global problems, increased commercial activity, productivity, benefits, competition between skills and technology, greater citizen participation in decision-making, improvements in public services, teaching and science, and so on and so forth (The World Bank, 2016).

In the face of a growing use of the internet of things (IoT) in everyday life with smartphones that can remotely connect an alarm or a household appliance, this technology is still in embryonic form in nursing care use (Mieronkoski et al., 2017; Ou et al., 2021; Wang et al., 2021). Also, in terms of the expansion of telecommuting during the COVID-19 pandemic, in many cases to stay permanently, remote nursing care is also incompletely developed, not least because of the legal aspect of the use of such digital technologies, the risk of a breach of cyber data security and other restrictions (Haghi Kashani et al., 2021; Khan & Salah, 2018; Kumar & Snooks, 2011; Stoyanova et al., 2020; Tsiknas et al., 2021). There are some lucky exceptions. The College of Nurses of Ontario have already published their telenursing practice guidelines (Collegue of Nurses of Ontario, 2020). Training in telenursing will be also a requirement for future clinical nurses (Gallagher-Lepak et al., 2009; Gibson et al., 2021; Rutledge & Gustin, 2021).

This research focuses on the clinician nurse, i.e., the nurse who is interacting with patients. The possibilities of using remote technologies for nurse management are not very different from any

other area of management, and nurse teaching and simulation models are also well-developed (Asimakopoulou, 2020; Gallagher-Lepak et al., 2009; Gibson et al., 2021; Rystedt & Lindström, 2001). Both areas fall outside the scope of this thesis although the last section approaches nursing management but still with a predominantly clinical focus.

The question of what constitutes telenursing is one of the research questions of this work, and is addressed in section 4.1 below, but it can already be advanced now, although it will later be better justified with the results of the analysis of publications that, leaving aside an unfertile conceptual debate, telenursing is defined for this research as any provision of nursing care ─whether in hospitals, primary care facilities or nursing homes─ through the use of a remote communication procedure, device or system.

However, and although etymologically telenursing implies any kind of remote care (including ordinary mailing), it usually refers to care administered through some form of information and communications technology (ICT) system (including telephone, chat, or messaging) (Souza-Junior et al., 2016).

Thus, telenursing can range from sending laboratory data by email, or the common use of telephone-based care (Imlach et al., 2020; Raphael et al., 2016; Souza-Junior et al., 2016), to incorporating computer-based videoconferencing, remote monitoring or diagnosis, remote widgets or terminals with complex technologies design (Kumar & Snooks, 2011; Vijayalakshmi et al., 2020).

This raises the not uncontroversial issue of who will employ these remote devices at the other end, and there is a tendency to consider, particularly in remote and rural areas, the possibility of incorporating «telepresenters,» i.e., operators with basic training, or

even robots (Sarder et al., 2017; Sikka et al., 2021). Telenursing encompasses all professional aspects of nursing.

Care delivery is seen here in a holistic approach and is therefore not limited to the physical part only, but includes the social, psychological, and spiritual aspects, as far as they are within the competence of the nurse (Carius et al., 2016; Papathanasiou et al., 2013). Telenursing is expected to increase the time spent with each patient, which is now scarce, and to decrease the downtime (between care proceedings) that now accounts for a significant percentage (Westbrook et al., 2011; Yen et al., 2018).

There are four key drivers for the rapid expansion of information and communication technologies in virtual care: i) technological advances, particularly in health informatics (Dreyer et al., 2006; Matsushita, 2020) contributing to a better systematisation, quality control, and self-assessment of care (Johnson et al., 2015; Rysst-Gustafsson & Eriksson, 2021; Schuelke et al., 2019); ii) a societal demand for equity of access (Richard et al., 2016) and for greater attention to be paid to the ageing population or to those living in remote areas (Llorent-Bedmar et al., 2021); iii) labour shortage of nursing and midwifery personnel, which is predicted to worsen in the coming years (Buchan et al., 2022); and iv) cost-effectiveness constraints (Grustam et al., 2018; Hagan et al., 2000).

Telework, at least in Spain, has not been enthusiastically promoted by the public authorities, which is logical considering the nation's high unemployment rate and the availability of millions of unemployed to take up face-to-face work (Belzunegui-Eraso & Erro-Garcés, 2020; Villanueva & Cárdenas, 2021).

The situation in health care is totally different, particularly for nurses (Buchan & Aiken, 2008; World Health Organization, 2013, 2016). Even before the pandemic, there was a shortage of almost five

million nurses worldwide, not counting those over 55 years of age (baby boomers), who will retire in this decade and may reach a similar number. But the pandemic has caused an outflow of more than one million professionals, so that we are now approaching a shortfall of seven million nurses, posing a serious nursing shortage problem (ICNM - International Centre on Nurse Migration, 2022; Radner, 1998). It is not only a problem of developing countries, but it also affects advanced countries and requires urgent action (Baker & Kim, 2004; Buchan & Aiken, 2008; Einhellig et al., 2020; Marć et al., 2019; Park & Yu, 2019).

Surprisingly, until now, no specific questionnaire had been designed to find out the clinical nurse's opinion on telenursing, nor had their opinions on the extent of its use been published with a holistic view. There is partial work on specific areas of specialisation, mainly on the phone (Holmström et al., 2021; Kaminsky et al., 2020; Kumar & Snooks, 2011; Paolilli et al., 2007; Pourbalouch et al., 2020; Snooks et al., 2008) and surveys from the client's point of view (Mattisson et al., 2019). Organisational changes usually come from the top down. This frequently causes disruptions and dysfunctionalities. Staff involvement becomes essential to ensure the success of any change (Erlingsdottir et al., 2018).

This research has been planned with four main goals: 1/ A review of the state of the art of telenursing, analysing what has been published on the subject, what communication methodology has been used and what definition can be obtained from these published works. 2/ To design a specific questionnaire to analyse the clinical nurse's opinion on telenursing. 3/ To test the questionnaire in practice and to obtain results through real feedback on its use by clinical nurses. 4/ To explore the possibility of using

indirect methodology to analyse other aspects of nursing work, taking the labour climate as an example.

The core of the thesis is to address a general research question: What is the position of the clinical nurse in relation to telenursing? This can be broken down into a number of more specific research questions corresponding to the sections in the text:

Section 4.1 answers two questions, **Q1**: Is there a definition of telenursing generally accepted by the academic world? **Q2**: What is the state of the art of telenursing according to published research?

The following three **sections (4.2−4.4**) form a triad, addressing the goal of information procurement, contributing to alleviating the paucity of information on the professional view of telenursing, including nurses who do not yet work with telenursing, but also among those who already do.

The research questions are: **Q3**: is it possible to create and validate a questionnaire for the assessment of alignment of nurses with telenursing, analysing separately the domains of usefulness, acceptance, and appropriateness? **Q4**: Is it possible to test it with different response profiles to assess its consistency? **Q5:** Once the questionnaire has been theoretically validated, is it feasible to administer it in a selection of EU countries? If so, what are the results? As expected, given the scarcity of dichotomous variables in the sample, the Rasch results for these three variables were inconclusive, and for this reason a transformation of the polytomous variables into dichotomous variables was carried out, allowing the entire sample to be analysed with the Rasch methodology. The results are presented in **section 4.4**.

The first obstacle encountered is that there are no validated questionnaires for this purpose, and that, in addition, questionnaires

based on the acceptance of technology, which were widely used for the incorporation of e-mail into professional life, have considerable biases, and often include leading questions (Davis, 1993; Lewis, 2018; Venkatesh & Bala, 2008).

A new structured questionnaire was designed, validated first by computer generation of the different possible response variants (**section 4.2**), and then by administering it in three EU countries with different economic profiles (**section 4.3**). The triad is closed with a further analysis of the data after dichotomous transformation (**section 4.4)** which provides additional validity of the questionnaire using Rasch methodology.

This last **section 4.5** presents research on the use of remote technology for nursing management by analysing the evolution of selected trending topics (personal protection, psychological distress, care practice and organisation-management) in three main nursing work settings: primary or hospital care and nursing homes, before, during and after the COVID-19 pandemic (2019−2022).[1] The research question here is: **Q6**: Can remote methods be used as an aid to nursing supervisors? In our case, is it possible to use a remote method to obtain information from the nursing labour environment that will be useful for nursing management?

[1] At the same time, it is a tribute to the work of all the health professionals who have faced, and sometimes lost their lives, in the pandemic Among them is Dr Javier Marco-Franco, the author's brother.

3. METHODOLOGY

As for the first work, aimed at revisiting all publications with the word telenursing in the title, and in order to analyse aspects such as the definition, the geographical spread of telenursing programmes, and many other issues commented on below, the enormous potential of *Trobes* has been used. *Trobes* is a search engine of the University of Valencia that allows access to 16 libraries/archives, 8,084 health journals, 155 databases, including virtually all of those used in health sciences. It also allows retrieving of full text publications through a unique and customisable search box. A database has been created with the results of the search and several data have been obtained using conditional (COUNTIF) functions.

The following three works, forming a triad, focused on the questionnaire, have been developed under the consideration that any new organisational innovative development involves analysing the impact of workers and this impact can be analysed from different perspectives (Razali & Vrontis, 2010; Rummler & Brache, 2013; Rutledge & Gustin, 2021). The questionnaire design progressed through five phases: 1/ literature review; 2/ construct; 3/ domain development; 4/ item (question) development; 5/ testing and validation (Kitchenham & Pfleeger, 2002; Parmanto et al., 2016).

This literature review (focused on questionnaires) evidenced interesting previous experiences such as the System Usability Scale (SUS) (Lewis, 2018), or the Technology Acceptance Models (TAM) (Davis, 1993; Venkatesh & Bala, 2008). The telenursing interaction and satisfaction questionnaire (Mattisson et al., 2019) was also useful because, although it is patient-oriented, it was be

used to find reverse questions to analyse the practitioner's point of view.

Initially, a pool of questions was gathered from the authors' independent contributions and suggestions, and following a method similar to Delphi, the texts were reformulated according to the Flesh-Kincaid grades in terms of complexity and level of comprehension (Bakken et al., 2006; Solnyshkina et al., 2017). After the first round, 49 questions were selected.

On this preliminary database, a selection of domains was made. From the data available it was found necessary to explore three basic domains:

- Perceived usefulness
- Prospective acceptance
- Appropriateness to nursing tasks

In this phase the size (number of questions) of the survey and the statistical methodology were also set. The type of variables was designed taking into account the planned further statistical processing: descriptive analysis; Classical Test Theory (CTT); and Item Response Theory (IRT) using Rasch analysis. The latter method is powerful for the validation of survey questions, but requires, except for reliability tests, dichotomous variables, or else very complex computational process still in development and beyond the scope of a nursing thesis. Therefore, a mixed solution was chosen, with Likert polytomous questions, which is a very well-developed method in the field of surveys, as well as dichotomous questions to be able to use the Rasch methodology. The length of the questionnaire ─and consequently the estimated time to complete it─ was carefully selected following the recommended principle of ‘the shorter the better’ (Amaresan, 2021; Hopper, 2017; Taylor, 2018).

Since it was decided that the questions should be paired to avoid bias, and at least three different questions are required per domain, a format of six questions (three pairs) was established for each of the domains of utility, acceptability and appropriateness, resulting in a total of 18 questions (Q1─Q18) for polytomous questions (Fan & Yin, 2003; Flake & Fried, 2020; Krosnick & Presser, 2010). An additional dichotomous question was also included for each domain (D1─D3). It was clear from the outset that the main benefit of such a question was primarily to test the consistency of polytomous responses, given that a total of three dichotomous questions per respondent obviously allows only for limited Rasch analysis. This brought the design to end up with 21 questions. For the final selection, starting from the 49 pre-selected questions, several rounds of exclusion of less relevant questions were carried out, until the 21 questions (18+3) on which there was complete agreement among the coauthors were left (final questionnaires are included as appendix I). The estimated time for answering the survey was 7 min.

Once the questions had been selected with their opposite pairs, they were randomly shuffled, following an online random number generator, resulting in the distribution shown in the table below.

Table 3.1

Randomisation of the variables carried out before generating the test.

	Polytomous		
	Usefulness	**Acceptance**	**Appropriateness**
	−18	4	17
	−8	−14	−10
	5	2	15
	−3	−19	−11
	21	12	20
	−13	−16	−6
Dichotomous	1	7	9

Note: Questions with a negative sign should be reversed before statistical analyses (1 = 5; 2 = 4; etc.).

Once the questions had been generated and translated, with some adaptations to the particularities of the countries (for example, in Portugal there are no nurse assistants), they were entered onto a digital form (*https://docs.google.com/forms*), although some centres requested a written version, and this paper format was also occasionally used.

The procedure implies that once the data have been obtained, and before analysing the results, the variables must be re-ordered so that each one occupies its corresponding domain.

Inconsistency in the responses was measured by comparing the dichotomous variables of each domain and their theoretical value (D_t) resulting from the sum of the Likert variables for each domain, with the formula applied to the spreadsheet:

$$IF(SUM(x:y) \geq 15;1;0)^2$$

where x:y represents the sum of the six polytomous variables for each domain. If the sum is equal to or greater than 15, the matching response of the dichotomous variable should be 1, while if it is less the response should be 0. This has also allowed to ruled out those cases where two or more inconsistencies were present. The inconsistency was also checked with the Rasch method.

In order to perform the first theoretical validation, and to be able to consider all possible response trends, i.e., all possible scenarios (majority in favour of telenursing, against, without bias, and also with consistency and inconsistency), six different databases were generated by computer, with 120 fictitious respondents for each of these databases, representing the different profiles. An asymmetry level of (2/3) was established for the case of biases for or against and an equal number of responses for and against in the case of

[2] Note that in the formula (1) page 3 of the article published in *Mathematics*, a one is missing before the five.

the neutral option. Each design in turn included two variants: well-matched responses (range of difference between pairs [–1 to +1]) and lesser matched responses (difference between pairs [–2 to +2]). The following table summarises the characteristics of these computationally generated databases:

Table 3.2
Codes and characteristics of databases.

Database Code	Symmetry	Pairwise Difference
Fic R + NO	Positive	Poor
Fic R + Rel	Positive	Good
Fic Sym NO	Central	Poor
Fic Sym Rel	Central	Good
Fic L—NO	Negative	Poor
Fic L—Rel	Negative	Good

The data were generated by complex nested combinations of random and conditional (if). So that once the first variable (1−5) is randomly generated, the paired variable fulfils the condition of being in the range of ± 1 or ± 2 as the case may be.

The following instruction is an example for the generation of the paired variable:

=IF(A103=5;(A103+RANDOM.BETWEEN(-2;0));IF(A103=4;(A103+RANDOM.BETWEEN(-2;1));IF(A103=3;(A103+RANDOM.BETWEEN(-2;2));IF(A103=2;(A103+RANDOM.BETWEEN(-1;2));IF(A103=1;(A103+ RANDOM.BETWEEN (0;3)))))))

In this way, data were generated for theoretical validation with the different response variables.

Descriptive methodology, CTT and IRT were used and published in the corresponding articles.

The following statistics for the polytomous variables were automatically generated with the spreadsheet for each of the databases:

Mean

Standard error

Median of medians

Standard deviation

Variance

Kurtosis

Skewness

Mean of the sums

Subject count

Similarly, for dichotomous variables, the percentage of favourable responses was computed.

It should be noted that the ordinal variable has been treated as numerical and, due to this restriction, the data only have a relative value (Kampen & Swyngedouw, 2000). The IBM-SPSS V26 software was used for the CTT statistics.

The internal consistency of each dimension was determined with the Cronbach alpha statistic:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\Sigma\alpha_k^2}{\alpha_{Total}^2}\right]$$

where *k* is the number of items, $\Sigma\alpha_k^2$ is the item variance and α_{Total}^2 is the total variance.

Cronbach's alpha uses the covariances between the items, whereas the standardised item format is based on the correlations between the items; in this case, this is already assumed as present. Therefore, the approach here is not to assume that the items have equal variances as in practice, this is not often the case. Table 4 (in

the paper) summarises the non-standardised Cronbach's alpha of the polytomous variables for each domain (based on covariances analyses) for each dimension. The 95% confidence intervals (CI) for Cronbach's alpha have been computed using the interclass correlation coefficients which give results identical to Cronbach's alpha (when calculated with the two-way mixed consistency or two-way random consistency models). Hence, this is a CI for alpha as well.

Principal component analysis was run to evaluate the strength of the partial correlation, i.e., how well the factors (items) explain each other, and to check the adequacy of the factor analysis. The Kaiser-Meyer-Olkin (KMO) values indicate the adequacy of sampling for the factor analysis and Bartlett's test of sphericity (covariance method and varimax rotation) analyses whether the correlation matrix is the identity matrix (null hypothesis), if this hypothesis is not rejected, the factor analysis is not appropriate. A KMO score above 0.6 indicates that the set of variables is sufficiently related to perform a factor analysis. An ANOVA analysis was performed to determine how the different parameters condition the total sum of the polytomous variables.

The Rasch model was used for the IRT.[3] This test was proposed by the Danish mathematician Georg Rasch after research between 1951 and 1959 and was first used to measure the intelligence of Danish soldiers and was subsequently widely used in psychometric assessments (Rasch, 1960). It was created for the analysis of dichotomous data, although later complex developments extended it to polytomous data, either ordinal (Andrich, 1978) or continuous (Hohensinn, 2018). However, these variants remain under very

[3] Virtually all worldwide references on the Rasch model including an online forum are available at *https://www.rasch.org/rmt/rmt213d.htm* (accessed on 28/2/ 2023).

limited development, and it has not been possible to obtain usable models.

It is a stochastic (probabilistic) model that assumes that the attribute (latent phenomenon, in our case the positioning of the nurse in relation to telenursing) to be analysed, can be jointly represented by a single global dimension that includes both the respondents (individuals) and the items (questions). Its stochastic characteristic assumes that some people with low ability can solve difficult questions and vice versa; subjects and items are measured in the same units, on the same continuum. Furthermore, the probability of giving a correct answer depends on the level of the respondent in relation to the attribute and the ease or difficulty of the item. Both together determine the probability that the answer is correct.

That is, it allows for a two-factor general rule: the first for personal ability and the second for item difficulty, expressed as logarithmic probability units (logits). It is a latent structure probabilistic model with a remarkably increasing use for scale evaluation.

The model analyses the responses of *n* individuals to *i* items and the probability of a positive (favourable, or correct response) outcome, ($X_{ni} = x = 1$) $x \in \{0,1\}$ (dichotomous in the original document), is given by the logistic function:

$$P(X_{ni} = 1|\beta_n, \delta_i) = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}}$$

where β_n represents the first factor (individual or person ability factor) and δ_i the second factor (item difficulty factor).

The Warm's mean weighted likelihood estimate (WLE) has been used, but a review of 215 studies and 23 software packages showed no significant differences between the different LE approaches (Nicklin & Vitta, 2022).

Both this statistic and that of expected a posteriori (EAP) ratio can be determined in the available R software (packages: MASS, eRm, Itm, TAM) and have been computed for both dichotomous and polytomous variables. In addition to reliability tests (EAP and WLE) the full Rasch model has been developed for the dichotomous variables. It should again be noted that with one variable per dimension, it is more of an exercise for future work that may include a larger number (at least three) variables per dimension but serves to complete the theoretical development of the method.

Recommended determinations include:

A) Andersen's likelihood ratio (LR) test for goodness of fit of the Rasch model.

B) Measurement of infit MNSQ (sensitive-inlier weighted mean squared value) and outfit (sensitive-outlier weighted). In Rasch methodology refers to the ability of the data to fit a model and is an essential element of the analysis. This infit (as root mean square) represents the fit of the data to the expected distribution. Infit values are often used to detect anomalous patterns in the data, such as wrong answers or over-responses. Infit can be calculated for an item or a person by averaging the corresponding values.

The outfit values, on the other hand, are used to assess the predictive ability of the data. They refer to the fits of the data to the default structured distribution.

The standardised (*t*) or mean squared value (MNSQ) of the infit, which is the mean of the weighted quadratic residuals with their weighted mean square (*W*), has been determined.

$$\text{infit (MNSQ)} = \frac{\sum_n^N W_{ni} z_{ni}^2}{\sum_n^N W_{ni}}$$

where W is the weighted root mean square and *z* represents the normalised residual, which for an individual *r* and item *q* would be:

$$z_{rq} = \frac{y_{rq}}{\sqrt{P_{rq}\left(1 - P_{rq}\right)}}$$

The following standardised values have been obtained. D1-D3 represent the dichotomous variables.

D1-Infit-t
D2-Infit-t
D3-Infit-t
D1-Outfit-t
D2-Outfit-t
D3-Outfit-t

Usually, acceptable values of weighted infit and outfit (–*t* or *Z*) range from –1.9 to +1.9. Data above 2 are considered to be unpredictable. Data below –2 are too predictable.

C) Beta measures, as indicated above, reflect the ability of an individual to provide a correct answer to an item (question in our case) of difficulty *δ.* Values close to 0 indicate adequate ability. There have been determined for each dichotomous variable:

Beta-D1 (0.95CI)
Beta-D2 (0.95CI)
Beta-D3 (0.95CI)

D) Dffclt and Dscrm are other measures of difficulty and discrimination in Rasch analyses. Item difficulty parameters (*xsi*) are estimates of the item's position on the logit scale representing the latent variable, assuming that responses are scored so that lower scores (*x* = 0) indicate lower positions on the latent variable. Lower item estimates on the logit scale indicate items that are more

difficult or that require people to have relatively higher positions on the construct (in this case more in favour of telenursing) to give a correct response. On the other hand, higher item estimates on the logit scale indicate items that are easier or require people to have relatively lower positions on the construct to give a correct answer.

They can be used to assess the level of difficulty of a particular item, as well as the ability of individuals to respond to different levels of difficulty. Dffclt is the level of difficulty of a particular item on a measure; an appropriate difficulty would be close to 0. Dscrm is the ability of an individual to discriminate between items of different levels of difficulty, so high values indicate good discrimination:

D1-Dffclt
D1-Dscrmn
D2-Dffclt
D2-Dscrmn
D3-Dffclt
D3-Dscrmn

E) P(x=1|z=0) is the probability that a person with a z-score of 0 has an x-score of 1. This probability is determined by the person's ability level and the difficulty of the item. Analogously, the following have been determined:

D1-P(x = 1|z = 0)
D2-P(x = 1|z = 0)
D3-P(x = 1|z = 0)

The Item Characteristic Curve (ICC) and Item Information Curve (IIC) are used to assess the internal consistency of Rasch data. The ICC curve measures the reliability of the measurement and assesses whether the measurement instrument is reliable in measuring the desired construct. In our case the slope of the ICC

represents the extent to which the probability of giving a positive response for nurses in favour of telenursing increases.

Shifts to the left are usually due to a high degree of ceiling effect, meaning that the items (questions) are too easy for the majority of respondents, together with an uneven distribution of scores, resulting in a large number of respondents scoring at the same (positive) level.

The IIC peaks at the difficulty value (highest item discrimination). It provides information about how much 'information' about the latent trait ability an item (in this case a question) provides. The most likely reason for the leftward shift of the IIC curves is that the items are too easy for the test subject group.

The methodology described so far has been used in the three articles of the triad, since the second one is simply the application of the methodology developed in the first article to the real nursing population surveyed in the selected countries.

As mentioned above, the Rasch analysis in these two publications is of limited value since the full development of the method requires enough dichotomous variables. Therefore, a third paper was completed to analyse the survey data by transforming Likert ranks into dichotomous variables. For these, values 1 (strongly disagree) and 2 (disagree) have become 0, and values 4 (agree) and 5 (strongly agree) have become 1. In the case of neutral values (3), the value of the dichotomous variable (D1–D3) corresponding to that domain has been used.

As for the last fifth work, the search procedure and selection of publications was based on the SJR (Scimago Journal & Country Rank) database, which establishes an independent indicator, after analysing the weighting of citations and the centrality of the vector

(eigenvector) of the graph, allowing the importance of a node in the network to be determined. It is designed for use with complex and heterogeneous citation networks such as Scopus, and includes 30,891 scientific journals, which offers advantages over other search procedures. At global level, publications with the subject area «nursing» through SJR yielded (2021) 640 journals. The maximum number of articles published (*N*), was estimated, assuming 12 issues per year (i.e., one issue per month, which gives an additional safety margin, as not all journals are published monthly), and an average of 20 articles per issue, resulting in an estimated total number of articles (*N*) of 640 • 12 • 20 = 153,600 articles per year, i.e., 614,400 papers, for the four years of study. In any case, given the size of the universe (*N*), the sample to study (*n*) does not vary by a small difference in *N.*

Two criteria have been used to determine the statistical sample. Firstly, the total universe of the sample, i.e., *N* = 614,400 articles, must be represented with a margin of error *d* = 0.05, *p* = *q* = 0.5, confidence interval = 99% (i.e., *Z* = 2.58) and, consequently, the total sample for this would be *n* = 665 articles (166 per year). Secondly, it has been established that each year must also have a representation with a confidence interval of 85% (*Z* = 1.44). Therefore, per year (for *N* = 153,600) this results in a sample of *n* = 207, which means a total of 828 articles.

For these calculations the well-established formula is used:

$$n = \frac{NZ_{\alpha/2}^2 pq}{[d^2(N-1)] + \left[Z_{\alpha/2}^2 pq\right]}$$

The time frame for the search was from January 2019 to December 2022.

The search for relevant literature on the working conditions of nurses during the COVID-19 pandemic was collected from different

databases, PubMed, EBSCO and CINAHL, Embase, Web of science. Searches were conducted combining the key related terms ‘nurse’, ‘employment’, ‘working conditions’, ‘health’ and ‘COVID-19’. The Boolean condition nurs* AND protection OR psychological OR practice OR organization OR management was used as a search string. The first data dump contained duplicate publications. This was checked by a computerised A-Z sorting of the Digital Object Identifier (DOI) field in a spreadsheet. Consequently, duplicate references detected in this way were removed and replaced.

The following conditions for articles were a requirement:
I) Each selected article should allow full analysis through access to the full text of the publication. This does not mean necessarily open access, but an access through the log-in of the coauthors.

II) The Digital Object Identifier (DOI) must be included, enabling a subsequent quality control check, and a revisit of the paper quickly if needed.

III) They should not refer to aspects related to specific specialities, or nursing units (cardiology, intensive care, etc.,) and should include original data, excluding secondary studies, reviews, or meta-analyses. All the studies should refer to working conditions during the COVID-19 pandemic, especially with relation to the nurse’s organization of the work situation and work environment. Note that this multidimensional approach is set for the specific condition of the pandemic of COVID-19. Other dimensions could be set for specific periods or analyses. Aspects related to specific clinical techniques (either general or specialised) were excluded.
The analysis of the included articles started by creating a formative categorization matrix with four pre-set categories, based on our adaptation of the theory and the determinant spheres established

in the SwAge model (Nilson, 2021; Nilsson, 2020, 2021; Nilsson & Nilsson, 2021).

IV) Following systematic reviews on the effect of the pandemic on nursing that demonstrate a multidimensional impact (Beattie et al., 2023; Liang et al., 2021), the topics (themes) were selected by grouping those multiple dimensions into four categories:

1/ Personal protection issues and personal accomplishment, related to fears and threats of contagion, feelings of worthwhile accomplishment, challenge, the extent of diversity and interest in the occupational duties, personal growth and development, the use of skills, and the amount of independence and autonomy at work (Beattie et al., 2023; Guedes Dos Santos et al., 2021; Llop-Gironés et al., 2021).

2/ Psychological outputs and rewards, related to satisfaction with work and interaction with patients (Birt et al., 2023; Fontanini et al., 2021; Gutiérrez-Fernández et al., 2023; Nagel et al., 2022; Saragih et al., 2021; Savitsky et al., 2021).

3/ Organizational and process and professional support satisfaction with the relationship with other nursing staff of any rank as well as other multidisciplinary professionals, motivation, appreciation, satisfaction, and stimulation in work tasks, including the significance of the employment relationship context for individuals' work and the provision of sufficient social support from the environment when needed (Buheji & Buhaid, 2020; Giri et al., 2021; Guedes Dos Santos et al., 2021).

4/ Management and satisfaction with the workload conditions, working hours, work pace, time for recuperation, considering relationships, social support, and participation, i.e., attitudes in the social context in which the individual finds himself/herself included

or excluded from the group (Birt et al., 2023; Gutiérrez-Fernández et al., 2023; Liang et al., 2021).

As for areas (the second variable in the analysis), they have been classified as:
A/ general nursing, primary care or not specified in the publication.
B/ hospital nursing.
C/ residential centres, nursing homes or similar.

A desk review was conducted on the obtained scientific literature. The dataset was read to get the whole picture of the phenomenon, with the participation of different reviewers (authors), that independently screened article titles and abstracts, and then the full articles that quantitatively or qualitatively identified the factors associated with working conditions during COVID-19 pandemic in hospitals; residential centres, nursing homes or similar; as well as in general nursing, primary care or not specified in the publication. Disagreements were resolved by involvement of a third reviewer as necessary. The data by topics and areas have been analysed with non-parametric statistics and displayed in graphical formats. Then, researchers first extracted all the data according to the categorization matrix available, continuing by calculating frequencies, percentages, averages, standard deviations, etc., according to the nature of the variables. Statistical assessment of changes over time was carried out with the non-parametric Chi-square statistic.

4. ‖ RESULTS

4.1. State of the Art of Telenursing. Definition. A Review of Three Decades of Publications.

This work has been extremely tedious, not only because of the need to review more than half a thousand articles, but also because in many cases it has been necessary to search for complementary data. Not infrequently, only the name of the hospital or the city was included, which made it very difficult to locate the work. It should be borne in mind that the name of a hospital may be well known in its region or even in its own country but may be unknown in other contexts. Also, there are cities with the same name that correspond to different regions or countries, and certain abbreviations may be popular in one country but not outside it. Despite the effort, the work yielded some very interesting data.

One of the notable features has been the repeated presence of publications from Iran, which has thus positioned itself as a leading country in telenursing publications. There were also notable absences from developed countries that have not generated any work on this topic. The choropleth map includes some nice visual information in this regard.

There is also a noticeable lack of focus on the nurse in the publications, which are much more patient-centred or focused on organisation and management.

The methodology used also came as a surprise, because the telephone has remained the predominant communication system used, with little use of computerised communication systems.

The text of the ongoing publication is as follows:

SYSTEMATIC REVIEW

TELENURSING: LESSONS FROM THREE DECADES OF PUBLICATIONS

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SUMMARY

Aim*:* The analysis of publications including the keyword telenursing in the title.

Design: Bibliographic review.

Methods: *Trobes* is a search engine of the University of Valencia, that allows the survey of more than 8000 journals in the field of health, including 155 databases such as CINAHL, Cochrane, Embase, EBSCO, Web of Science, Medline, etc**.** The following data were taken from the selected publications with "telenursing" in the title: First author, year, DOI/ISSN, journal, peer review, country, focus (patient/ management/nurse), clinical discipline in which the patient is included, type of publication, telenursing method used. No restriction by year was established. Results were generated using computerised conditional filtering.

Results*:* From a total of 624 documents, 311 publications were finally selected after filtering for duplicates and unrelated items. The first publications found date back to 1994. USA (58) and Iran (48), and Sweden (36) were the countries with the highest number of publications. There are many regions of the world without any report. Peer-reviewed articles represent 72.3%, but the majority (46%) focus on organisational aspects; caller/patient accounted for 41.8% and the nursing focus accounted only for 12.2%. Approximately half of the articles referred to general nursing. As for the clinical disciplines, Endocrinology, Cardiology,

and Oncology ranked the highest. The telephone method was the most widely used (67.3 %). Computers were used only in 16.0%.

Conclusions*:* Telenursing is not synonymous with the use of computers. Telephone is the main method of telenursing described. Many countries have not reported any telenursing publication and given the increasing limitation of nursing resources; additional gains could be made by implementing a telephone-based telenursing programme*.* It is not necessary to wait for complex computerised systems before setting a such a programme.

Keywords: Telenursing; bibliometric reviews, digital nursing, remote care, nursing shortage, e-nursing.

INTRODUCTION

2024 will mark three decades of published articles including the word “telenursing” in the title [1], [2]. This locution is composed of two terms or concepts: tele and nursing. Without a doubt 'tele' refers to “remote” from the Greek τηλε-tēle, which means at a distance [3]. For nursing we will use, the definition of the Royal College of Nursing which is: «The use of clinical judgment in the provision of care that allows people to improve, maintain or regain health, cope with health problems and achieve the best possible quality of life, whatever their illness or disease or disability, until death» [4, p. 3]
The combination of both terms gives us an idea of how advances in health care are applied, using Information and Communication Technologies (ICTs) in nursing, which allows a link to be established between patient and nurse at a remote level [5]. The expansion of ICTs has facilitated the development of care technologies that connect patients and health professionals, in our case nurses, allowing continuity of remote care to such an extent that a person can experience an extended ongoing relationship with a nursing professional or clinical nursing team.

From this conceptual basis, this paper analyses the publications that include the word “telenursing” in their titles, answering certain questions and making considerations concerning whether it is necessary to use some type of electronic or digital system to provide remote care. Does using ICT necessarily mean using computers [6]? Are care instructions given to assist an injured seafarer on a ship using Morse code (even with semaphore flags or a light signal from a lamp or mirror) considered telenursing? Are written instructions for routine care of a diabetic considered a telehealth procedure?

MATERIAL AND METHODS

Trobes is a search engine of the University of Valencia that allows access to 16 libraries/archives, 8,084 health journals, 155 databases and resources, including AMEDEO, CINAHL, Cochrane, DOCUMED, Embase, ENFISPO, ERIC, EBSCO, Proquest, Gale, IBECS, IEEE, InDICEs CSIC, ISSN, JCR, JSTOR, MEDLINE (Ovid), Nursing (Ovid), OECD, ProQuest, Pubmed, Web of Sciences, Scopus, among others, facilitating the retrieval of publications through a unique and customisable search box. It includes e-journals, e-books, doctoral theses, and physical resources, most of them accessible in full text.

Using *Trobes,* and the keyword “Telenursing” without restriction of years, the documents found (up to 15 of September 2023) have been analysed in full text, creating a database incorporating the following information.

1 │ ID: Paper’s number, first author, DOI/ISSN.

2 │ Geographical and temporal data: Year of publication and country where the study was conducted.

3 │ Journal.

4 │Type of publication: I) Books or book chapters with general content. II) Organization, management, models, or questionnaires. III) Opinions, journalistic articles, newsletters, and viewpoints. IV Reviews without original data. V) Focused on education. VI) Original clinical research and surveys.

5 │ Quality of publication: Peer reviewed (Y/N). Research (Y/N) (i.e., including hypothesis, methodology, statistics, etc.).

6 │ Main focus of the paper (1= Caller/patient, 2= Management/education, 3 = Nurses).

7 │ Clinical domain (Y/N), with N for general nursing and Y for those papers referring a specific clinical domain.

8 │Telenursing methodology used (NA = Not applicable or available, T = Telephone, C = Computer, V= Video, VC= Videocall, SMS = Short message, SSNN = Social networks, Web).

RESULTS

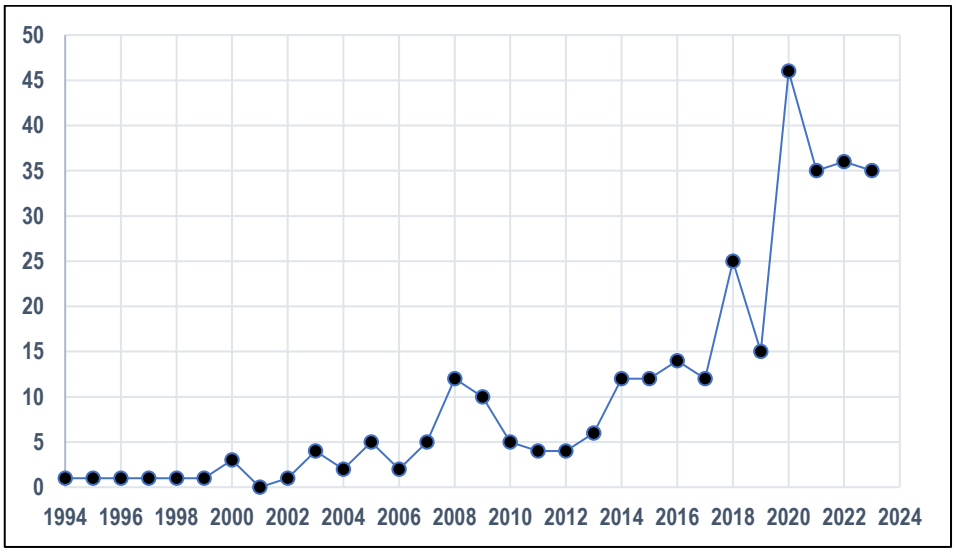
1│ *Selection and filtering of results.*

A total of 624 papers were found, but many repetitions were detected by checking the DOI/ISNN. Additionally, the search tool selected papers where telenursing was not included in the title and/or were not mainly focused on telenursing. The final selection included 311 publications.

2│ *Geographical and temporal evolution.*

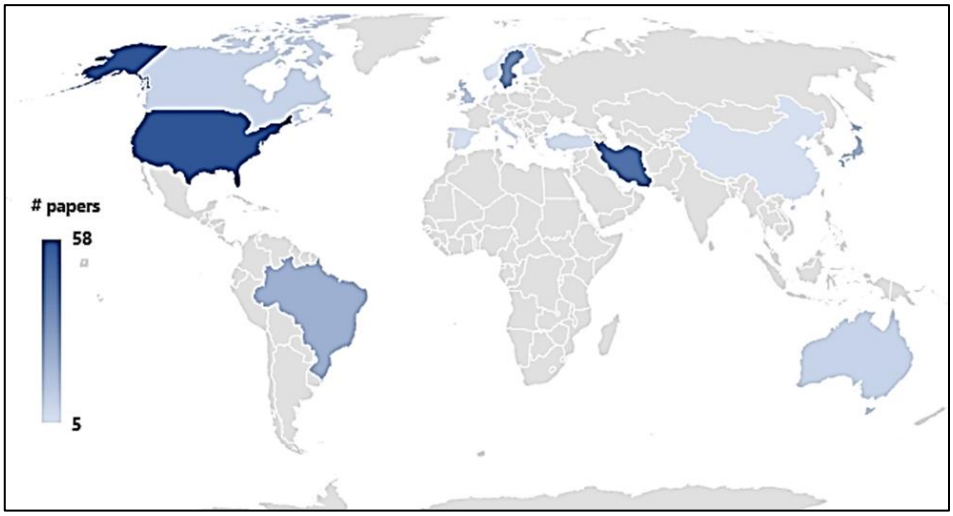
There have been found papers with the keyword “telenursing” in the title since 1994. The first two recorded publication were those of [2] from Denmark and [1] from the USA. There have been a growing number of publications over the years with a peak of 46 in 2020 (figure 1).

***Figure 1**:* Number of papers on telenursing per year. Up to September 15, 2023.



Regarding geographical distribution, only the USA (58), Iran (48) and Sweden (36) have published over 30 papers in the period. The data are also presented in the form of a Choropleth map for those countries with 5 or more publications.

***Figure 2**:* Choropleth map of countries with 5 or more publications on telenursing (1994-2023 [15 Sep.]).



3 Journals.

There is a considerable dispersion of journals in which articles have been published, led by the *Journal of Clinical Nursing* (15

publications), the *Scandinavian Journal of Caring Sciences* (7) and the *Journal of Advanced Nursing* (6). Also noteworthy, the *BMC* as a group of journals included 12 papers.

4│ Type of publications.

The number of books published on telenursing is low, only 6, plus 4 book chapters. There is also a small number of works on questionnaires focusing on patients (one) or on nursing (three). The highest percentage of publications deal with organisational aspects, with occasional publications on programmes, models, or management; this group accounts for 37% of the papers reviewed. Note that some topic reviews also include original research in the form of a bibliometric study.

Table 1. Classification of the articles by type of publication

Type of publication	N[er]	(%)
Organization/management/models/questionnaires	78	37
Topic review	56	27
Opinion: Journalism/newsletter, viewpoints	44	21
Original research/surveys	18	8
Books or book chapters	10	5
Education	5	2

Note: Published papers on Telenursing from 1994 to September 15, 2023.

5│ Quality of publications.

Peer reviewed papers accounted for 72.3% (225). Articles that include a consistent research development, with hypotheses, data collection, statistical processing, etc., accounted for 39.6% (123). This also includes review articles, or others, which include such a methodology.

6│*Main focus of the paper.*

Most of the papers (46%) are focused on organisational aspects of telenursing, 41.8% on the caller/patient and only 12.2% focused on nurses.

7│*Clinical domain*.

The organization of this section corresponds to the terminology used by the authors in their articles for the classification of patients based on their possible pathologies. Note that nursing specialities and medical specialities do not match. What is reported here is the clinical domain in which the patient's clinical problem is included.

Slightly over half of the papers (162) refer to a clinical domain (52.1%). There are three clinical domains each representing about 10% of the papers. The leader is endocrinology, mostly focused on diabetes care, followed by cardiology and oncology. Table 2 presents the clinical domains with at least 5% of papers.

Table 2. Classification of the articles based on clinical domains.

Clinical domain	Percentage
Endocrinology	15%
Cardiology	13%
Oncology	12%
Paediatrics	9%
Neurology	9%
COVID-19	8%
Mental health	7%

Note: Published papers on Telenursing from 1994 to September 15, 2023.

8│*Telenursing methodology.*

Excluding those cases where telenursing methodology is not included or not applicable, the most frequent method published is telephone contact. The data are presented in table 3.

Table 3. *Telenursing methodology used*.

Telenursing method	Number	Percentage	
Not available/applicable	155	49.8%	(Over applicable)
Telephone	105	33.8%	67.3%
Computer technology	25	8.0%	16.0%
Video	12	3.9%	7.7%
Videocall	5	1.6%	3.2%
SMS	3	1.0%	1.9%
Social Networks	3	1.0%	1.9%
Web	1	0.3%	0.6%
Telephone + SMS	1	0.3%	0.6%
Video + SMS	1	0.3%	0.6%
Total	311	100.0%	100%

Note: Published papers on Telenursing from 1994 to September 15, 2023.

DISCUSSION

The professional qualification of nurses in the use of digital care technologies and the development of the Electronic Medical Record have allowed the inclusion of ICTs in the nursing practice improving patient's access to health systems and equity [7]–[10].

Care coverage has been expanded through teleconsultation, telemonitoring, the use of videoconferencing, text messages sent by nurses to patients through the use of social networks and the telephonic following-up of patients [8], [11]–[14]. All this is designed to be used synchronously and/or asynchronously [15], [16], increasing the role of nurses in developing and improving the effectiveness of care.

Telenursing also extends to the development of health promotion and education, facilitating adaptation and coexistence with risk factors, and the improvement and promotion of self-care [7], [14], [17].

Through the exchange of information to promote patient and professional satisfaction, nursing has gained widespread prominence. Thanks to these technological advances, nurses can better meet today's emerging care needs, responding better to the health demands of individuals and societies, providing improvements in time and resource management at lower cost, facilitating early interventions and contributing to better adherence to treatment [7], [8], [18], [19].

However, despite advances in the use of ICTs in nursing practice, professionals still have difficulties in understanding telenursing as a care modality, and even the term itself is sometimes confusing and imprecisely defined [20]. According to a survey in EU countries, nurses estimated that only 34% of their professional activity could be done remotely [21] stressing the fact that a significant part of care needs to be provided face-to-face.

Nursing is struggling with a growing shortage of professionals, and any elements that can contribute to reducing this deficit should be incorporated as soon as possible [22], [23]. In the awareness and knowledge of nursing staff about telenursing [24], its effectiveness and the quality of health care [25] and in the successful implementation of a telenursing programme, institutional support and supervision are essential [26].

In this regard, the nursing perspective has been conspicuously absent. Apart from one article in Farsi [10] and therefore limited in scope, there have been few publications on questionnaires concerning the patient’s perspective [27] and almost no systematic approaches to consistently survey nursing professionals' positions on telenursing [21], [28], [29].

Our data reveals some important aspects. Firstly, on the definition of telenursing itself. Scholars have generated terms such as

telehealth, e-health, mHealth (mobile health), telenursing, and similar, that seem to overlap, but are they really overlapping concepts? Do we have a concept of telenursing? Recently, McVey stated that a conceptual analysis of telenursing has not yet been published [30]. Sousa and colleagues, after a systematic review and final selection of 37 studies, stated that telenursing is the incorporation of ICTs in nursing care using technological products (listed) [5]. The same requirement of ICTs is reported by [31]. Another question is whether immediate real-time interaction is a requirement [16].

Should ICTs be part of the definition of telenursing? This depends on what do we consider to be ICTs. If we assume that ICTs requires the use of computers or digital systems, the answer is no. However, if we turn to the UNESCO concept of ICTs we see that non-digital methods such as analogue telephones are also considered ICTs [32]. With this broad definition in mind, it is clear that remote care will require some form of communication and, consequently, ICTs could be included in the definition.

However, if we look at the results of our study (table 3), the telephone was the most used method (67.3%). Given that the earliest articles found on telenursing date back to the 1990s [1], [2] it is clear that not all the telephones in the world were digital at that time. In any case, it is difficult to see the difference between providing telephone care over an analogic line, even with a rotary phone, and a digital mobile phone.

The third most used method according to the literature reviewed is video recording (7.7%). This type of recording allows patients to review care instructions and is extremely useful in cases where, due to repetition of the process, it is not uncommon for some steps of care to be shortened or omitted. Diabetes care is a perfect example.

The reminder of the self-care procedures and diet in the form of a video is not an activity that requires real time interaction.

Requiring the use of computers for a nursing care to be considered telenursing would exclude 84% of the articles published on this topic. Furthermore, we do not know what technologies will emerge in the future, so it not unreasonable to limit the definition to its original etymology that telenursing refers to remote nursing care. If we add the use of ICT in the definition, this should be done by considering the concept in its broadest sense.

It must be said, as a weakness detected, that in many cases it has been extraordinarily difficult or even impossible to clarify which method of telenursing has been used. Based on the experience of this review, we recommend that papers should clearly and prominently specify the ICT methodology used.

Another notable aspect of our study, which is evident in the Choropleth map, is that while there are three leading countries in terms of telenursing publications, i.e., USA, Sweden and Iran, there are important regions, such as Africa, Central Europe, Russia, and India, the entire American continent except Canada, USA, and Brazil, where no publication on telenursing has been found. Again, in many cases it was not easy to elucidate where the study was conducted. Mentioning the name of a hospital (which may be well known in your area, but unknown in other countries), without including any other reference, requires additional search work. US state acronyms may not be known outside the country, and even using the first author's email address is not always helpful, as he or she may be doing research abroad. The extensions of .com, .gov or .edu also make precise location impossible to clarify. It is strongly recommended that future studies clearly define the place and country where the study has been carried out.

Taking into account that, both in the experience of this study and according to the definition of ICTs, the telephone must be fully accepted as a telenursing procedure, and that various self-care devices exist (to self-control of blood glucose, blood pressure, temperature, etc.), the implementation of a telenursing system, a pending issue in many countries, should not wait for the development of complex ICT systems.

However, admittedly, we are moving towards a server in the cloud, with connected smart peripheral devices, laboratory, imaging and management software, electronic medical records and apps for patients, healthcare staff and administration services supported by artificial intelligence [33], [34]. This future, in some cases already a reality, does not have to be, and should not even be, the first step towards the establishment of a telenursing programme. In this regard, the 17 standards published by the American Academy [35] can be useful in assessing which outpatient care may be initially selected to start a telenursing programme.

Assuming that we can consider as quality papers peer-reviewed articles (72.3%) and those that are not merely descriptive but include an analytical procedure that starts from a working hypothesis and subsequently develops a methodology, statistical data processing and analysis (39.6%), we can conclude that the scientific level of telenursing publications is high.

In relation to the focus, it is striking that it is mainly dedicated to patients (41.8%) or to the organisation (46%). Only 12.2% of the articles focus on the nurses themselves.

The patients with endocrinologic pathologies (diabetes mellitus), together with those with cardiologic and oncologic problems have attracted the most interest from the authors of the publications (table 1).

CONCLUSIONS

Despite almost 30 years having passed since the first recorded publication on telenursing, the concept remains elusive. To move forward, it seems appropriate to limit this term to the simple, etymological sense of telecare without adding adjectives or specifications of the technology used, which can be limiting. If it is finally decided to include ICT in the definition, it should be understood in its broadest sense without necessarily linking it to advanced digital or computerised technology.

The geographical development of the literature on telenursing shows significant gaps and opportunities, as many countries have not yet started to realise its potential. It is true that much nursing care requires face-to-face care but, given a shortage of nursing staff that will unfortunately only increase, taking advantage of all options to provide care more quickly and without losing quality or efficiency is an imperative challenge.

Interpretation and analysis of future publications will be greatly facilitated if the authors clearly specify the location, particularly the country, where the studies have been conducted, and clarify the telenursing methodology employed, with much greater detail than has so far been published.

The development of telenursing programmes is to be encouraged, which, as described above, need not start with complex computerised systems. Telenursing through telephone communication alone or preferably combined with algorithms and standards of care, together with simple remote feedback from callers, offer excellent opportunities to start developing such telenursing programmes.

ADDITIONAL INFORMATION: AUTHORSHIP CONTRIBUTION STATEMENT

Marco-Franco: conceptualisation, formal analysis, data curation, writing, editing.

Reis-Santos: supervision, resources, validation, edition.

Camaño-Puig: supervision, validation, writing, editing.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest regarding this work. We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

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4.2. Instruments for the Assessment of Alignment of Nurses with Telenursing. Development and Testing of the Questionnaire. [4]

Descriptive statistics of databases show the expected asymmetries as evidenced by their skewness and kurtosis. They are summarized in table 4.2.1. It should be noted that statistical processing ordinal and categorical variables provides only limited results.

Table 4.2.1
Descriptive statistics of computer-generated databases.

Database	Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel
Data (ȳ)	Polytomous data					
Mean of means	2.87	2.62	3.02	3.00	3.32	3.42
Median of medians	2.75	2.00	3.00	3.00	4.00	4.00
Standard deviation	0.50	0.50	0.47	0.49	0.44	0.44
Variance	0.25	0.25	0.22	0.24	0.20	0.20
Kurtosis	−1.99	−2.02	−1.51	−1.78	−0.83	−0.86
Skewness	−0.20	0.12	−0.72	−0.50	−1.09	−1.07
Mean of sums	66.00	56.33	85.00	74.33	88.33	88.00
Subject count	120	120	120	120	120	120
	Categorial data					
Mean	0.55	0.47	0.67	0.62	0.74	0.73
Standard error	0.05	0.05	0.04	0.04	0.04	0.04
Positive responses (%)	55.0	46.9	66.7	61.9	73.6	73.3

Note: For database details see Table 3.2 (p. 21).

The next table presents the Cronbach (covariance method).

Table 4.2.2
Cronbach-α results for each domain and database.

Database	Fic R + NO			Fic R + Rel			Fic Sym NO			Fic Sym Rel			Fic L—NO			Fic L—Rel		
Domains	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap
Cronb- α	0.84	0.86	0.84	0.94	0.95	0.94	0.83	0.80	0.82	0.94	0.95	0.94	0.82	0.83	0.84	0.94	0.95	0.95
	0.94			0.98			0.93			0.98			0.94			0.98		
95% CI	0.93–0.96			0.91–0.98			0.91–0.95			0.97–0.98			0.92–0.95			0.97–0.98		

Note: Domains: U = Usability, Ac = Acceptance, Ap = Appropriateness.

[4] Marco-Franco, J.E., Reis-Santos, M., Barrachina-Martínez, I., González-de-Julián, S., & Camaño-Puig, R. (2022). Validation of a new telenursing questionnaire : Testing the test. *Mathematics*, 10(2463), 1–13. https://doi.org/10.3390/math10142463

The principal components analyses are summarized in next table.

Table 4.2.3
Principal components analysis.

Database	Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel
KMO	0.93	0.95	0.94	0.93	0.93	0.94
Bartlett	0.000	0.000	0.000	0.000	0.000	0.000

As expected, the results showed that the Rasch test of the EAP reliability score of 0.70 for the dichotomous data is not as good as the 0.94 for the Likert-5 polytomous data. However, the infit-t and outfit-t of the dichotomous variables are very centred, and the coefficients of reality of the polytomous variables, using Warm's mean weighted likelihood estimates, are always >0.9. This suggests that a purely dichotomous questionnaire would not be as appropriate as a mixed model including polytomous Likert-scale data, unless the loss of information could be counterbalanced by a larger number of categorical variables that would increase the survey completion time.

In conclusion, both the CTT and IRT approaches confirm the validity of the theoretical model for assessing nurses' positioning in relation to telenursing. The analyses showed that the programmed variations were adequately detected by the tests performed and that the methodological procedure is therefore sensitive to changes in the response profile.

Published paper is included in Appendix II.

4.3. Results of the Study on the Alignment of Nurses with Telenursing. A Survey in Three Selected Eu Countries.[5]

Article 3 shows the results of the survey that was administered in selected countries (Spain, Portugal, Poland) with different economic profiles within the European Union.

A very relevant piece of information obtained from this study is that the nursing staff surveyed consider the applicability of telenursing in the profession to be rather limited, including the provision of integrated (holistic) care. The score obtained was 34.3% (33.5−36.3). Inconsistent or careless answers were found in 16 cases (7.1%) and excluded from the count.

As for CCT, Cronbach's alpha, KMO and Bartlett's tests confirm the adequacy of the results. Overall, Cronbach's alpha is very high (0.945), with interclass correlation of 0.945. KMO 0.952 and Bartlett p<0.001 (Table 4.3.1).

Table 4.3.1
Principal component tests for polytomous variables by domain and overall.

Domain	Cronbach's alpha	Interclass correlation	Interval (95%CI)	KMO	Bartlett
Usefulness	0.785	0.785	0.739-0.826	0.819	<0.001
Acceptance	0.878	0.878	0.851-0.901	0.884	<0.001
Appropriateness	0.883	0.883	0.857-0.905	0.871	<0.001
Total	0.945	0.945	0.934-0.955	0.952	<0.001

As expected with IRT analysis when considering a construct with only three categorical variables, the EAP reliability is 0.52,

[5] Marco-Franco, J.E., Reis-Santos, M., Barrachina -Martinez, I., Jurewicz, A., & Camaño-Puig, R. (2023). Telenursing: The view of care professionals in selected EU countries. A pilot study, *Heliyon*, Volume 9, Issue 6, e16760. ISSN 2405-8440. https://doi.org/10. 1016/j.heliyon.2023.e16760.

indicating an insufficient fit of the Rasch model when only dichotomous variables are included; this is confirmed by WLE of −0.49. The real utility results of the IRT analysis for polytomous variables is the EAP reliability of 0.95, indicating that the rating scale fits the underlying Rasch model very well. The Warm's likelihood estimate (WLE) also provides a very high score (0.94).

The results are not unexpected. Most nursing care needs face to face activities, but even so, there is a substantial part of the activity that practising nurses consider may be covered by e-nursing.

What may be concluded from this paper is that the questionnaire meets the expected objective as a starting tool, to guide the process of change towards remote care, reinforcing the need of nurse participation in managerial decisions. Although limited to three selected EU countries, it could easily be extended to analyse the issue in other countries in the future.

This pilot study proves that this questionnaire is robust and allows separate analysis of the three domains (usefulness, acceptability, and appropriateness). Categorial data should not be used alone, but in conjunction with polytomous data. Results show a favourable opinion from nurses about telenursing, although they consider that appropriateness for providing holistic nursing care is limited (34.3%).

Published paper is included in Appendix II.

4.4. Further Validation by Rash Analysis of Data Transformed to Dichotomous Variables.

This fourth work emerged as convenient to complement the technical assessment of the questionnaire with full Rasch methodology. The three dichotomous questions of the questionnaire were not enough, as anticipated, to obtain the full power of the Rasch methodology, so the results obtained were transformed into a 5-choice Likert scale to perform a complete Rasch analysis. In this respect, the collaboration of Professor Dr Zhang Quan from China was very much appreciated.

The text of the ongoing publication follows:

Short Communication

Further validation by Rasch analysis of Telenursing questionnaire

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Telenursing is a growing process [1], [2] in which several disciplines are interested. On the one hand, we are witnessing the unceasing development of Information and Communication Technologies (ICT) in all fields, which will inevitably require human resource departments to increase the competence of their professionals [3]. Additionally, we are also facing a serious prediction of a lack of nursing staff in the future [4], which requires decisive preventive action. The interest in patients' views on telenursing [5], runs parallel to the growing interest in improving equity of access and care for an ageing population or in rural areas, where there is now the added problem of drought and climate change [6], [7]. The development of telenursing systems requires a complex multidisciplinary approach [6], [8].

We have developed and published the first questionnaire to assess nurses' positioning of telenursing in the dimensions of usefulness, acceptability, and appropriateness of remote methodology in nursing care, focusing on general nursing staff, whether they were already using remote systems or not. The model was initially designed and tested with computer-generated results [9] and then administered to a sample of 225 nurses from selected European

countries [10]. The questionnaire was designed to be answered in less than 10 minutes [11] and included 18 polytomous questions (Q1−Q18) and 3 dichotomous questions (D1−D3). These three dichotomous questions correspond to a global approach to each of the domains of usefulness, acceptability, and appropriateness of telenursing. This design allowed for a good analysis using Classical Test Theory (CTT), but the Item Response Theory (IRT) methodology was incomplete as only the three dichotomous variables were available.

Since the implementation of a telenursing system is a complex decision, involving ICT managers, medical, nursing, human resources, management, administration and health management, and policy makers, it is necessary to ensure that the method and its corresponding questionnaire are adequately tested. We have therefore to further analyse the results by other means (IRT) [12]. Full Rasch analysis is only possible with dichotomous data. In this paper we present the results of the Rasch study of the sample as in [10] by transforming the 18 polytomous variables into dichotomous variables. These have been obtained by assigning Likert scale values (1 or 2 = 0; 4 or 5=1). In the case of a score of 3, the value of the corresponding dichotomous variable (D1−D3) has been assigned. Alternatively a Partial Credit Model [13] could be used.

The Rasch study was carried out, with the following results:
Estimation of respondent's ability: The analysis of θ shows a range between +3.093 and –3.042. Most of the values are positive, indicating a good ability of the respondents to answer the questions. Of the 225, 20 values scored +3.093 and 2 values –3.042.

Item difficulty (beta analysis): Range from +1.579 to –1.797. Mean $\beta = 0$, Mean standard error = 0.21822. Since the results are based on responses from a questionnaire corresponding to a 5-choice

Likert scale transformed into dichotomous data, the items thus obtained do not so much indicate the difficulty as the favourable/unfavourable positioning of telenursing. The fact that the sigmoid curve (not plotted) has left shift suggests that the questions have been easy to understand, with an average probability of giving the correct answer in about 75% of the cases.

The infit-t (or Z) and the outfit-t, the typical standardised values of the degree of person or item factor fit, are shown in table 1 (annex). As commented in our previous paper, the measurement of infit and outfit in Rasch analysis refers to the ability of the data to fit a measurement model [14], [15]. Only one value, that corresponding to question four, is out of range.

The analysis of the matching of answers to paired questions is good (mean 82.75%), except for Q4, which has a significantly lower matching rate (62%) with its paired question (Q5). Considering that all Q5 indices are within range, it can only be concluded that the understanding of question Q4 was poor or subjects who were favourably disposed towards telenursing accidentally or mistakenly chose the «disagree» option. This question (Q4) needs to be rephrased to increase clarity.

The regression coefficients were EAP reliability = 0.825. WLE reliability = 0.715. The goodness of fit is summarised in table 2:

Table 2: Results of goodness-of-fit statistics

Statistics	value	d.f.	p-value
Collapsed Deviance	415.231	270	0.000
Hosmer-Lemeshow	26.197	8	0.001
Rost Deviance	1154.787	262126	1.000
Casewise Deviance	2209.332	2758	1.000
R-Squared Measures			
Pearson R^2	0.412	Accuracy	0.830
Sum-of-Squares R^2	0.412	Sensitivity	0.926
McFadden R^2	0.541	Specificity	0.605
Area under ROC	0.878	Gini coefficient	0.756

In the supplementary material the data are presented with a greater breakdown.

The Rasch analysis confirms the results obtained previously using CTT. The questionnaire is valid, although question four should either be rephrased to improve the consistency of responses or deleted with or without its pair (question five).

This additional report complements our previous publications and makes the questionnaire more consistent and secure. It will be useful in the implementation of future telenursing systems worldwide, given its simplicity and the good results obtained from its analysis, both with the CTT methodology and with the IRT data now available.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgments

Our thanks to Dr Silvia González-de-Julián (SP) and Dr Alina Jurewicz (PL), who contributed to the previous data collection and processing.

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Declaration of Generative AI and AI assisted technologies in the writing process

Not used.

Author contribution statement

Dr Julio E. Marco-Franco wrote the text, developed the computer transformations, statistics, and design of the model.

Dr Ramón Camaño-Puig co-led the work, contributed to model development implementation, and data analysis.

Dr Margarida Reis-Santos, PhD, co-led the work, reviewed the text, and contributed to the data analysis and key discussion points.

Dr Isabel Barrachina-Martínez collaborated in the methodological development and statistics with independent validation analysis of the findings.

Ethics

Not applicable in this work.

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Annex: Supplementary materials.

Original published questionnaire (editable doc format):

https://www.cell.com/cms/10.1016/j.heliyon.2023.e16760/attachment/3dc6c1a7-f664-44f2-b299-aa782d37e52f/mmc1

Note that reordering the questions is required and some also should be score-reversed (1=5, 2=4) before running the statistics. See our previous paper for further information: *Mathematics*, 10 (2463), p. 3, 2022; doi: 10.3390/math10142463.

Table 1: Infit and Outfit with standardised values.

Item	X^2	d.f	p-value	Outfit MSQ	Infit MSQ	Outfit t	Infit t	Discrim
Q1	119.217	154	0.983	0.769	0.821	-0.662	-1.190	0.690
Q2	138.842	154	0.804	0.896	0.913	-0.488	-0.803	0.620
Q3	173.410	154	0.136	1.119	1.004	0.452	0.057	0.575
Q4	830.090	154	0.000	5.355	1.917	11.188	7.826	-0.106
Q5	94.934	154	1.000	0.612	0.820	-1.420	-1.258	0.679
Q6	220.117	154	0.000	1.420	1.243	1.843	1.987	0.427
Q7	74.151	154	1.000	0.478	0.723	-1.828	-1.910	0.741
Q8	99.854	154	1.000	0.644	0.764	-1.681	-2.012	0.723
Q9	200.918	154	0.007	1.296	0.885	0.830	-0.655	0.629
Q10	151.675	154	0.538	0.979	0.854	0.037	-0.966	0.645
Q11	167.497	154	0.216	1.081	0.907	0.430	-0.762	0.642
Q12	141.963	154	0.747	0.916	1.037	-0.225	0.305	0.561
Q13	121.936	154	0.973	0.787	0.905	-0.892	-0.726	0.644
Q14	109.110	154	0.998	0.704	0.823	-1.446	-2.060	0.554
Q15	121.302	154	0.976	0.783	0.802	-0.997	-1.729	0.697
Q16	96.534	154	1.000	0.623	0.864	-1.806	-1.093	0.656
Q17	118.093	154	0.986	0.762	0.898	-1.109	-0.841	0.642
Q18	156.746	154	0.423	1.011	0.974	0.124	-0.264	0.440

Note: The infit refers to the fits of the data to the expected distribution. Infit values are often used to detect anomalous patterns in the data, such as erroneous responses or over-responses. Outfit values, on the other hand, are used to assess the predictive ability of the data. It refers to the fits of the data to the structured, default distribution. Standardised infit and outfit (-t or Z) acceptable values range -1.9 to +1.9. Over 2 data are unpredictable. Data under -2 are too predictable.

Table 2: Item difficulty parameters (xsi).

xsi.index	xsi.label	item	estimation
1	1	Q1	-3.0024
2	2	Q2	-1.7472
3	3	Q3	-3.0627
4	4	Q4	-1.1057
5	5	Q5	-2.8290
6	6	Q6	-2.0418
7	7	Q7	-3.0627
8	8	Q8	-2.3149
9	9	Q9	-3.3179
10	10	Q10	-2.9434
11	11	Q11	-2.1756
12	12	Q12	-2.6654
13	13	Q13	-2.3627
14	14	Q14	-0.8620
15	15	Q15	-2.1756
16	16	Q16	-2.3149
17	17	Q17	-2.1756
18	18	Q18	-0.8620

Note: In the Rasch analysis, both item difficulty and ability estimates are placed on the same logit scale. The item difficulty parameters (xsi) are the estimates of item location on the logit scale representing the latent variable. Higher values of xsi indicate more difficult items or require people to have relatively higher placements (or ability estimates).

4.5. Exploring Indirect Methods for Nursing Supervisors and Managers.

What is most remarkable about the results of article 5 is that the method was able to demonstrate statistically significant changes over the study time (tables 4.5.2 and figure 4.5.1).

Table 4.5.2
Differences in topics over the four years (2019 - 2022).

Topics ▶	Protection (1)	Psy/Mental H. (2)	Proceed. (3)	Management (4)	
▼ Years	n_1 (%)	n_2 (%)	n_3 (%)	n_4 (%)	
2019	4 (2)	34 (16)	38 (18)	131 (63)	207
2020	15 (7)	56 (27)	30 (14)	106 (51)	207
2021	9 (4)	122 (59)	25 (12)	51 (25)	207
2022	9 (4)	63 (30)	60 (29)	75 (36)	207
X^2= 127.5; p= 0.000001	37 (4)	275 (33)	153 (18)	363 (44)	828

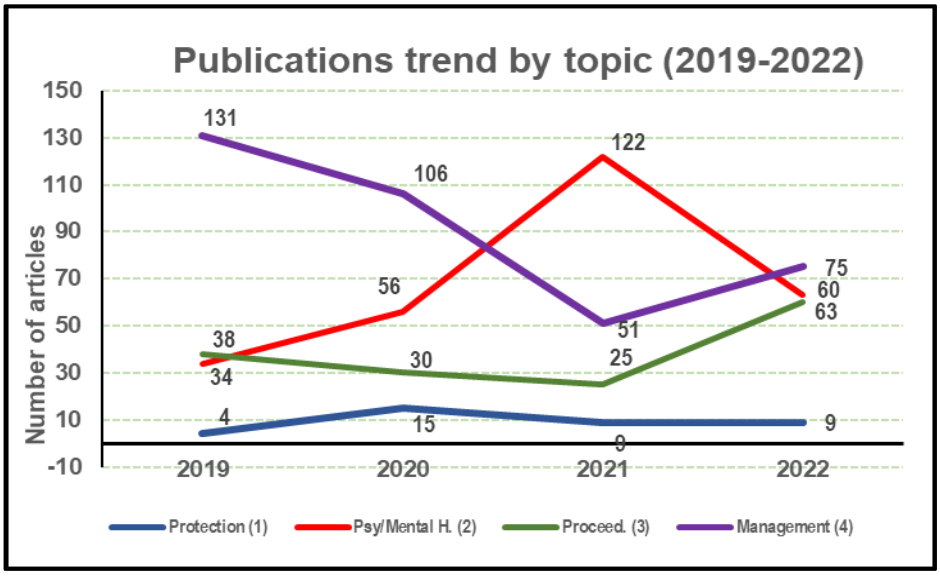

Fig. 4.5.1. Overall analysis of topics over the years.

As seen, a significant peak in the thematic of psychological aspects is evident, coinciding with the worst time of the pandemic. Staff paid less interest, as reflected in publications, to management issues.

The figures 3 to 5 in the paper (see pp. 80-81) present the data broken down by area of work. As can be seen in these graphs, the behaviour was similar in primary care and hospital care, but in nursing homes the problems that had the greatest impact were those related to the management and adaptation of the centres to the pandemic.

The pattern of psychological problems peaks earlier (2020) in primary care than in hospital care (2021) but the increase in this case is more pronounced.

As conclusion for this study, remote technology for assessing aspects such as work climate, through analysis of staff publications, proves to be a useful tool, which does not require the ongoing administration of surveys. The data, once collected, can be computed in multiple approaches, including disaggregated areas or themes over time.

The study presented shows that the method is sensitive to changes in the working environment, as was detected throughout the COVID-19 pandemic.

This methodology makes it possible to estimate behaviour in similar situations in the future and thus to establish preventive actions and learn useful lessons for such situations. Items and areas can be set according to the intended focus of the study.

The general idea presented here is that a remote methodology can be useful for obtaining data that may be applied later. It depends on the issue to be studied, and on the field of interest, given that publications can be narrowed down, or even extend to conference

presentations by staff. The method presented here for nursing can be applied as a distance method in other professional areas of healthcare, or even outside of it.

The text of the ongoing publication follows:

ARTICLE

Remote evaluation of the work environment through bibliometric analysis. The example of nursing in the pandemic.

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Abstract

Aim*:* Evaluate the usefulness of an applied mathematical method for obtaining remote data useful in team management.

Design: Analysis of nursing publications before, during and after the Covid-19 pandemic by the following topics: personal protection, psychological alterations, nursing procedures, and organisation-management in primary care, hospital, and nursing home areas.

Methods*:* A statistically significant sample of a four-year production (2019-2022) of scientific nursing articles was selected and tested with non-parametric methodology to determine changes and trends over time.

Results*:* Statistically significant changes, mainly in mental health and management issues, were found, but the different areas (primary care, hospital, and nursing homes) followed their own patterns.

Conclusions*:* The bibliometric analysis proved to be a discerning and useful method to detect and measure changes in the nursing work climate.

Implication for the profession and/or patient care: This procedure could be useful, especially when direct assessment surveys are not convenient or possible, such as in the case of pandemic workloads. It allows problems to be detected remotely and the proposing of corrective solutions.

Impact: The study addresses the use of bibliometric remote methodology. Although the findings refer to its applicability to work climate, this procedure may have an impact on future research on other topics or areas as an additional monitoring tool.

KEY WORDS
Applied mathematics, Telenursing, health planning, labour climate, bibliometrics, COVID-19.

1 │INTRODUCTION

Direct tests are obviously the most accurate and the quickest way to obtain results but have the disadvantage of time consumption and a wearing effect in the case of repetition. Furthermore, their administration can be problematic in the situation of work overload.

We propose the analysis of publications as a useful remote indicator for management. While it is true that bibliometric studies provide information with a certain time lag, as the process of writing, editing, peer-reviewing and publishing the article takes time, it has the advantage of not consuming additional resources, and can be repeated as many times as necessary, focusing on different topics and areas of work. Once appropriately selected, the continuous monitoring of topics and areas included in the publications provides indirect dynamic assessment that does not require direct staff surveys.

This study has been conducted at a global level, but could have focused on specific publications, by geographical area or by professional field. As a first approximation, a global scope seemed appropriate and simplifies the analysis, given that many professionals publish in journals outside their own country, although the managers of an organisation can control the publications generated by their institution in any language.

2 │BACKGROUND

Work climate assessment has been carried out for decades, ranging from the analysis of the impact of work on miners [1] to the most recent and sophisticated psychosocial intervention programmes [2]. They provide a useful improvement in the work environment by reducing conflict among employees, strengthening group cohesion, enhancing leadership, increasing trust in management, making employees more aware and competent in interpersonal relations, and increasing their responsibility in their daily work [3]. Evaluations have also included meta-analysis of the impact of environment support variables, such as the role of peer, supervisor, and organisational support [4].

Comprehensive works have been published on how to assess work climate by administering questionnaires both at general level (Copenhagen Psychosocial Questionnaire [CPQ]) [5] and at nursing level [6], including telework [7], [8]. However, the CPQ in its normal format includes 141 questions and 30 dimensions, and in its reduced version still has 44 questions and 8 domains.

3 │THE STUDY

3.1 │Aim

The aim of this study is to evaluate a mathematical method applied to obtain useful data in team management. The evolution of the selected trend themes (personal protection, psychological distress, care procedures and organisation-management) has been analysed in three main working environments: primary health care (PHC), hospital and nursing homes, before, during and after the Covid-19 pandemic (2019-2022).

3.2 │Sample size

The search procedure and selection of publications was based on the SJR (Scimago Journal & Country Rank) database, which establishes an independent indicator after analysing the weighting of citations and the centrality of the vector (eigenvector) of the graph, allowing the importance of a node in the network to be determined. It is designed for use with complex and heterogeneous citation networks such as Scopus, and includes 30,891 scientific journals, which offers advantages over other search procedures. At a global level, publications with the subject area 'nursing' yielded 640 journals through SJR (2021). The maximum number of articles published (*N*), was estimated, assuming 12 issues per year (i.e., one issue per month, which gives an additional safety margin, as not all journals are published monthly), and an average of 20 articles per issue, resulting in an estimated total number of articles (*N*) of 640 • 12 • 20 = 153,600 publications per year, i.e., 614,400 papers for the four years of study. It should be noted that, in any case, given the size of the universe (*N*), the sample to study (*n*) does not vary for a small difference in *N*.

Two criteria were used to determine the statistical sample. The first is that the total sample universe, i.e., *N* = 614,400 articles, should be represented with a margin of error d = 0.05, p = q = 0.5, a confidence interval = 99% (i.e., Z = 2.58) and, consequently, the total sample for this results in *n* = 665 articles (166 per year). Secondly, it has also been sought that each year has, additionally, a representation with a confidence interval of 85% (Z =1.44), Therefore, per year (for *N* = 153,600) this results in a sample of *n* = 207, which means a total of 828 articles.

For these computations, a well-established formula [9] was used:

$$n = \frac{NZ_{\alpha/2}^2 pq}{[d^2(N-1)] + [Z_{\alpha/2}^2 pq]}$$

3.3 | Methodology

The time frame for the search was from January 2019 to December 2022.

The relevant literature on the working conditions of nurses during the COVID-19 pandemic was collected from different databases, PubMed, EBSCO, CINAHL, Embase and Web of Science. Searches were conducted combining the key related terms ‘nurse’, ‘employment’, ‘working conditions’, ‘health’ and ‘COVID-19’. The Boolean condition nurs* AND protection OR psychological OR practice OR organization OR management was used as a search string.

The first data dump contained duplicate publications. This was checked by a computerised A-Z sorting of the Digital Object Identifier (DOI) field in a spreadsheet and duplicate references detected in this way were removed and replaced.

1) Each selected article should allow full analysis through access to the full text of the publication. This does not necessarily mean open access, but access through the log-in of the co-authors.

2) The Digital Object Identifier (DOI) must be included, enabling a subsequent quality control check to be carried out and to revisit the paper quickly if needed.

3) The articles should not refer to aspects related to specific specialities or nursing units (cardiology, intensive care, etc.,) and should include original data, excluding secondary studies, reviews, or meta-analyses. All the studies should refer to working conditions during the COVID-19 pandemic, especially in relation to the nurse’s organization of the work situation and work environment. Note that

this multidimensional approach is set for the specific condition of the pandemic of Covid-19. Aspects related to specific clinical procedures (either general or specialised) were excluded.

4) The analysis of the included articles started by creating a formative categorization matrix with four pre-set categories, based on our adaptation of the theory and the determinant spheres established in the SwAge model [10]–[13]. Following systematic reviews on the effect of the pandemic on nursing that demonstrate a multidimensional impact [14], [15], the topics (themes) were grouped as follows:

I/ Personal protection issues and personal accomplishment: this factor included fears and threats of contagion, feelings of worthwhile accomplishment, challenge, the use of skills, and the amount of independence and autonomy at work (Beattie et al., 2023; Guedes Dos Santos et al., 2021; Llop-Gironés et al., 2021).

II/ Psychological outputs and rewards: related to satisfaction with work and interaction with patients. Also satisfaction with the relationship with other nursing staff of any rank and other multidisciplinary professionals, burnout, motivation, appreciation and stimulation [2], [18]–[22].

III/ Organisational procedures and professional support in work tasks, including the importance of the context of the employment relationship for individuals' work and receiving sufficient support when needed [16], [23], [24].

IV/ Management: working hours, work pace, time for recuperation, considering relationships, social support, and participation, i.e., attitudes in the social context in which the individual finds him/herself included or excluded in the group [2], [15], [22].

Regarding areas (the second variable in the analysis), these have been classified as:

A/ general nursing, primary care or not specified in the publication.
B/ hospital nursing.
C/ residential centres, nursing homes or similar.

A desk review was conducted on the obtained scientific literature. The dataset was read to obtain the whole picture of the phenomenon, with the participation of different reviewers (authors), who independently screened article titles and abstracts, and then full articles that quantitatively or qualitatively identified factors that were associated with working conditions during COVID-19 pandemic in hospitals; residential centres, nursing homes or similar; and general nursing, primary care or not specified in the publication. Disagreements were resolved by the involvement of a third reviewer as necessary. The date by topics and areas were analysed with non-parametric statistics and displayed in graphical formats. Researchers first extracted all the data according to the categorization matrix available and then obtained statistics according to the nature of the variables. Statistical assessment of changes over time was carried out with the non-parametric Chi-square statistic.

4 │ FINDINGS

4.1 │ Overall data

The following figure 1 shows the core procedures used in paper selection using a Prisma flow diagram.

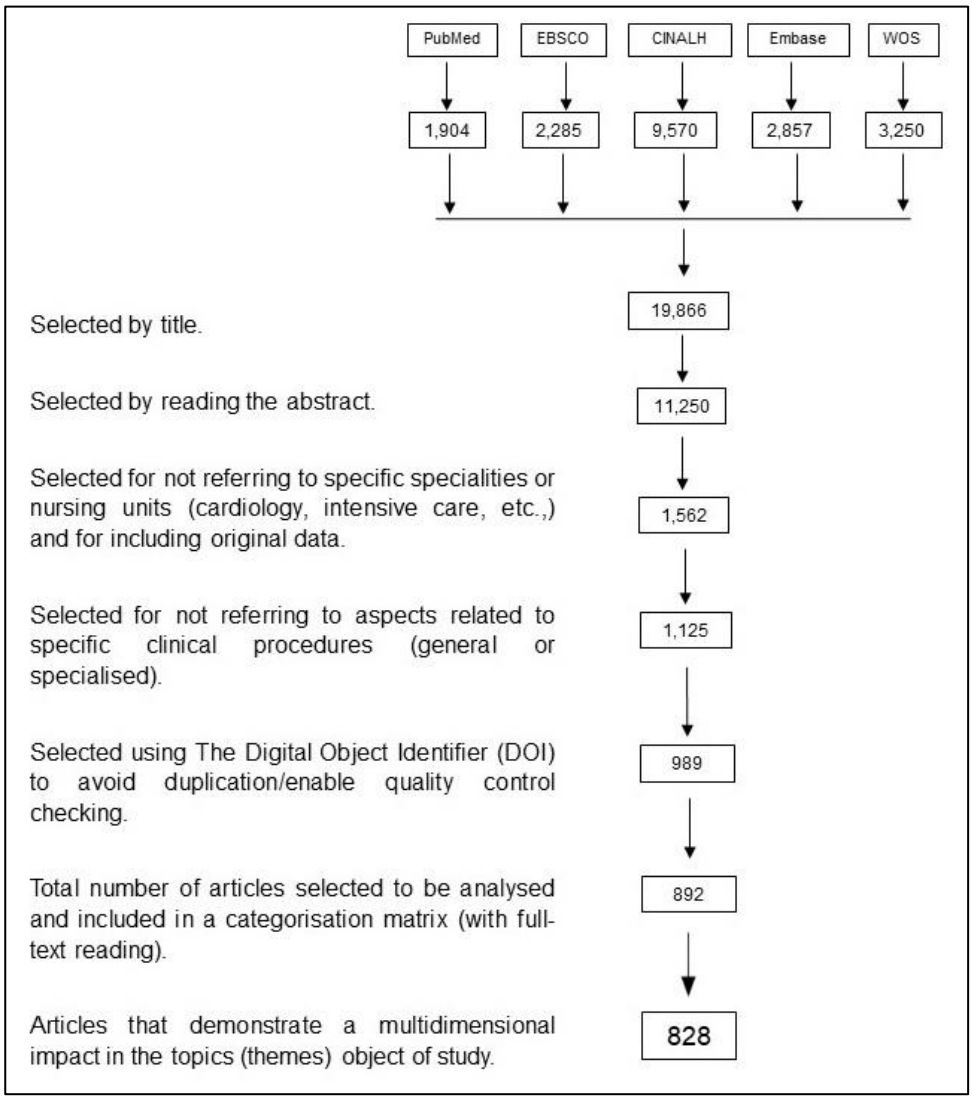

Fig. 1. Prisma diagram of article selection process.

Overall, a total of 828 articles were included, divided into 37 (4%) on protection, 275 (33%) on psychological disorders, burn out, etc., 153 (18%) on procedures (excluding those specific to one speciality) and 363 (44%) on management. More detailed information per area (field) is presented in Table 1:

Table 1
Summary of topics and areas 2019-2022

Topics ►	Protection (1)	Psy/Mental H. (2)	Proceed. (3)	Management (4)	
▼ Areas	n_1 (%)	n_2 (%)	n_3 (%)	n_4 (%)	
General (A)	25 (5)	147 (32)	71 (15)	217 (47)	460
Hospitals (B)	10 (4)	117 (44)	48 (18)	90 (34)	265
N. Homes (C)	2 (2)	11 (11)	34 (33)	56 (54)	103
	37 (4)	275 (33)	153 (18)	363 (44)	**828**

When the evolution over the years covered in the study was reviewed to detect whether there have been any significant changes, it was observed that these are notable, with a remarkable increase in psychological issues (X^2= 127.5; p= 0.000001) (Table 2).

Table 2
Differences in topics over the four years (2019 -2020). Number of papers and percentage.

Topics ►	Protection (1)	Psy/Mental H. (2)	Proceed. (3)	Management (4)	
▼ Years	n_1 (%)	n_2 (%)	n_3 (%)	n_4 (%)	
2019	4 (2)	34 (16)	38 (18)	131 (63)	207
2020	15 (7)	56 (27)	30 (14)	106 (51)	207
2021	9 (4)	122 (59)	25 (12)	51 (25)	207
2022	9 (4)	63 (30)	60 (29)	75 (36)	207
X^2= 127.5; p= 0.000011	37 (4)	275 (33)	153 (18)	363 (44)	828

When analysing the overall data graphically, it can be seen that mainly management topics decrease (from 131 publications in 2019 to 51 in 2021), but also procedural topics, while psychological topics experience a huge increase reaching their maximum in 2021 with 122 publications after starting the series with only 38 papers two years earlier. All topics show a trend towards a return to their previous values (Figure 2).

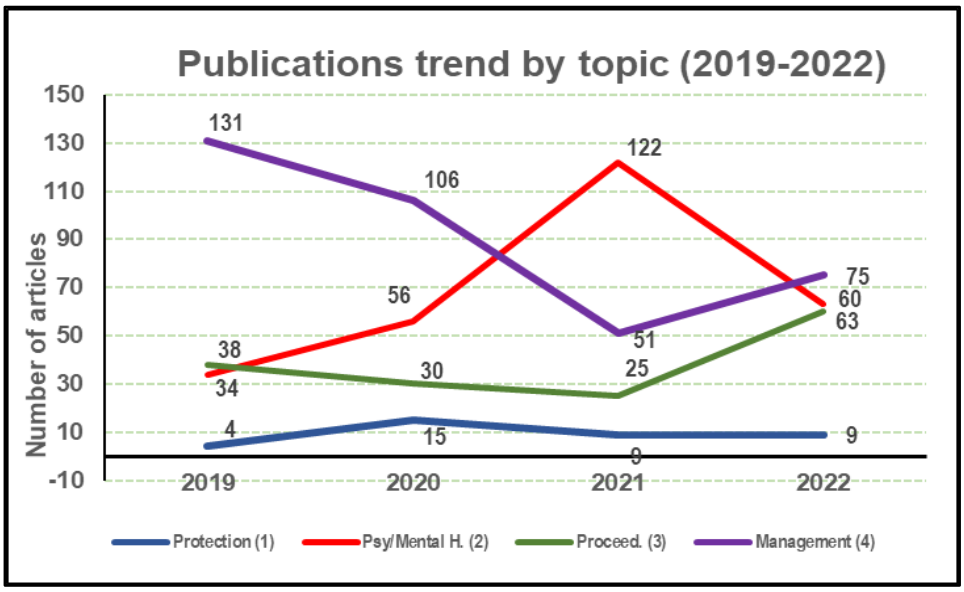

Fig. 2. Overall analysis of topics over the four years.

4.2 │ Analyses by areas

The analysis by each area of work provides additional information of interest. In primary health care (PHC) the most notable changes were the decrease in publications related to management (in two years, this changed from 108 to 11 articles) and the increase in psychological-mental issues, particularly in the first year of the main pandemic outbreak (rising from 22 to 50). With the stabilisation of the pandemic situation, indicators tend to return to their previous values. Additional details are included in figure 3.

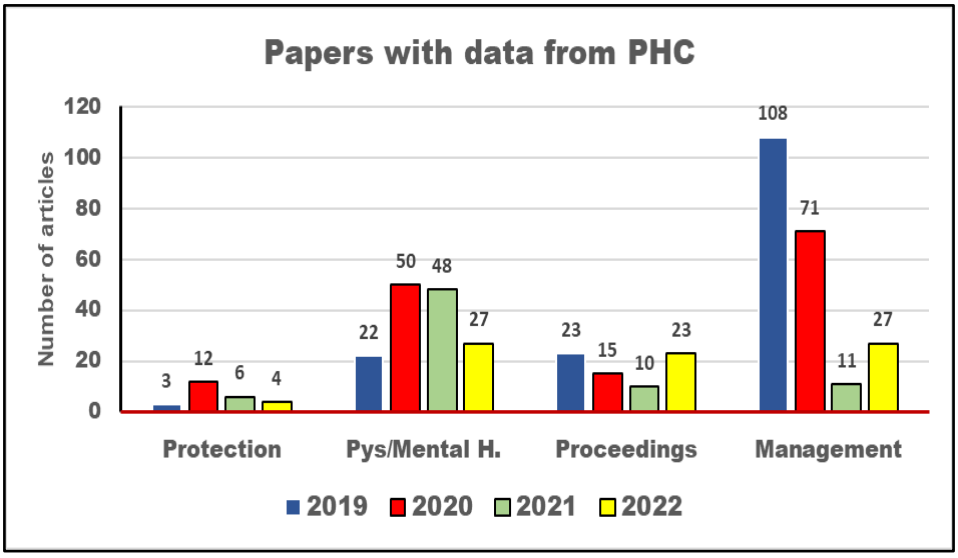

Fig. 3. Evolution of papers on topics over the four years (primary health care).

Regarding hospital care, psychological-mental issues also increased very significantly, but peak later in 2021 with 69 publications. In this area there was also an increase in management-related issues (from 9 to 39), with a peak also in 2021, which corresponds to the year of highest morbidity and mortality of the pandemic, especially in its first months [25] (Figure 4).

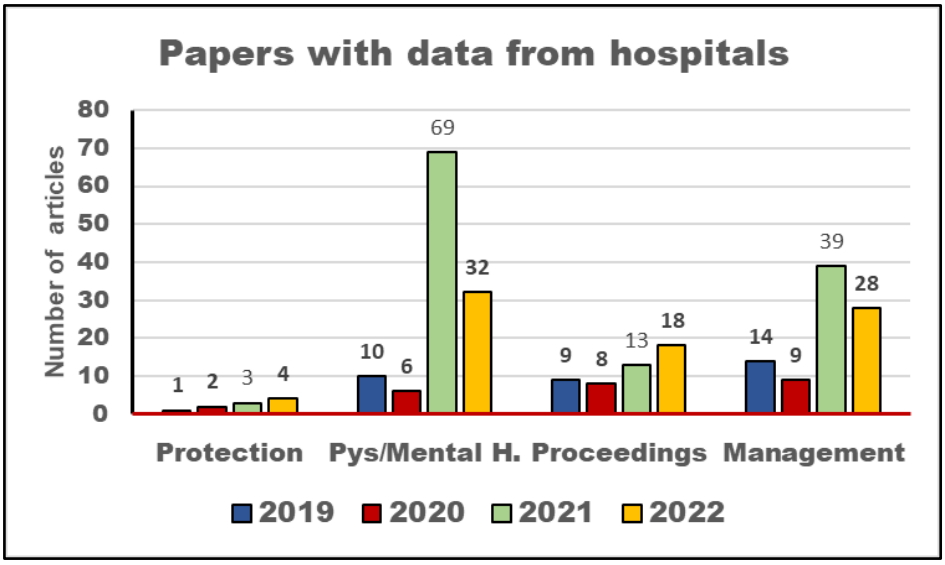

Fig. 4. Evolution on topics over the four years (hospital care).

Regarding nursing homes, staff faced different challenges than their hospital nursing counterparts due to their isolation, leadership roles, professional legal obligations and ethical responsibilities [14], [18], [23]. The psychological aspect was not greatly affected, as they do not have acute patients or emergency departments, but the data suggest a remarkable adaptation to new proceedings (peaking in 2022 with 19 papers) and management issues, both at the beginning (26 papers) and the end of the main epidemic outbreak (20 papers) (Figure 5).

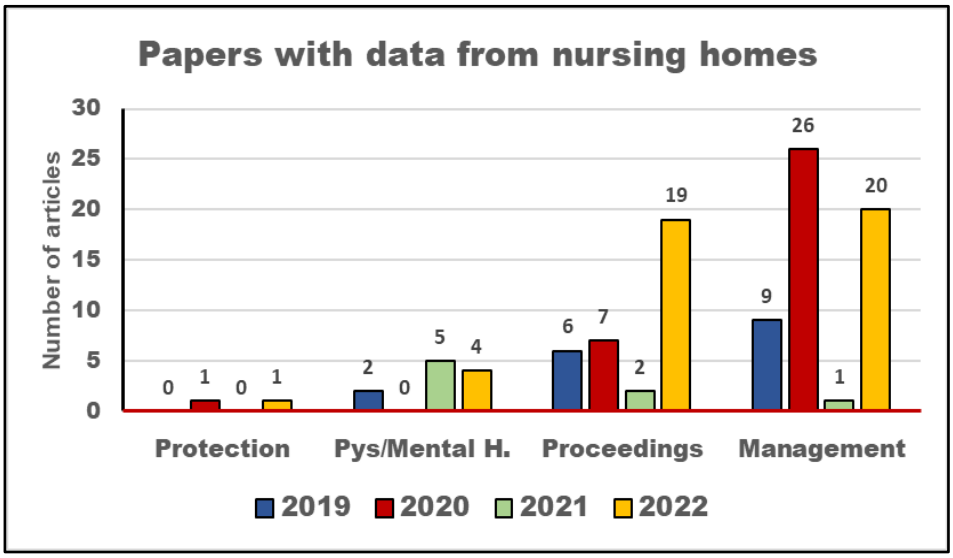

Fig. 5. Evolution on topics over the four years (nursing homes).

5 | DISCUSSION

Given the multitude of published studies, these constitute a good source of data to be processed using mathematical procedures within the reach of any manager, and to obtain results that can be applied in various fields, such as personnel management. There are previous experiences of bibliometric analysis being applied to nursing, as in the case of stroke [26], and bibliometrics has been used as an instrument to measure quality [27] or work climate, but these latter studies require the classifying and grouping of the

multitude of data and series to be evaluated. When applying such analysis to scientific literature, there is the advantage that the information is easier to obtain thanks to powerful search engines for academic publications. In addition, the health sciences have implemented mathematics, mainly statistics, in their studies [28], [29]. In the bibliometric approach, these techniques can become sophisticated, including piecewise regression [30], keyword extraction algorithms and alternative algorithms (altmetrics) usable not only as an index of impact metrics of papers, but applicable to other settings [31]. Bibliometric studies allow for repeated monitoring of data without overburdening staff with surveys or other evaluation procedures.

Nurses played a key role in the health system's response to the challenge of the COVID-19 pandemic, not only in providing direct care to patients, but also as an essential element in training and education, which was critical throughout the pandemic outbreaks in reducing the risk of exposure to infection. These nursing tasks require, in addition to adequate staffing, professional team planning, including measures to assess the work environment and minimise the physical and emotional impact, as well as a systematic response to stress factors [32].

With the outbreaks of COVID-19, any planned programme to assess the work environment or any other aspect of health care management was overwhelmed by workloads, anxiety, depression, transitioning through emotional changes, including fear of the risk of transmitting the disease to family members, among other resilience-related issues, as a paradigm of a society whose patterns have notably changed [33], [34]. Some health care staff chose not to return home daily in order to prevent possible contagion in their families. In other cases, such as in nursing homes, nurses were

obliged to remain in the institution by the rules. How to analyse and quantify work environment aspects in such circumstances?

Studies such as that conducted in the Philippines involving 325 nurses, 123 (38.8%) of whom had dysfunctional levels of anxiety, are encouraging and open the door to the idea that it is not only possible to measure the degree of dysfunctionality caused by a devastating and unforeseen event such as a pandemic, but also to develop measures to reduce the emotional impact on nurses [35].

In addition to the manager's own interest in identifying problems and challenges, key aspects that staff will value positively are; the assessment of the working environment accompanied by a detailed explanation of corrective actions, showing empathy and emotional support, committing to the implementation of appropriate protective measures and training [36].

The main objective of this paper is to demonstrate how a remote technology for nursing management — in this case bibliometric — can be useful to assess the evolution of the work climate. The COVID-19 pandemic became a suitable period to analyse. Information was obtained from scientific publications, in two aspects, firstly, as a disaggregated analysis by themes (topics) and areas, and secondly as a dynamic expression of nursing concerns over the years studied.

The general data reflect what the nursing staff have suffered during this period, psychological problems, fatigue, stress, burnout, and the evolution of these over time. There is also an increase in concern about protective measures. But above all, organisational aspects have given way to other more worrying issues, and their partial recovery over time (Figure 1).

Moreover, it seems that the evolution has not been the same for each area, although the final analysis of this difference is not the

objective of this study, which is rather the presentation of a method for obtaining the data for subsequent analysis by those with responsibilities for improving the work environment.

All three areas analysed share an increase in mental health issues, but with some differences. For PHC, the mental overload peaks earlier (2020) than in hospital care (2021), while for nursing homes this is not a great issue, as they are not subject to overload from admissions with COVID-19.

The second major change occurs with management. Primary care staff become less interested in this subject as the pandemic advances, but it is an important question at the beginning and the end of the period for nursing homes, and throughout the process in hospital care.

6 │CONCLUSIONS

Remote technology for assessing aspects such as work climate, through analysis of staff publications, proves to be a useful tool which does not require the ongoing administration of surveys. The data, once collected, can be computed in multiple approaches, including disaggregated areas or themes over time.

The study presented shows that the method is sensitive to changes in the working environment, as was detected throughout the COVID-19 pandemic. This methodology makes it possible to estimate behaviour in similar future situations and thus to establish preventive actions and learn useful lessons.

ADDITIONAL INFORMATION: AUTHORSHIP CONTRIBUTION STATEMENT

Marco-Franco: conceptualisation, formal analysis, data curation, writing, editing.

Reis-Santos : supervision, resources, validation, edition.

Camaño-Puig: supervision, validation, and editing.

González-de-Julián: formal analysis, data curation, project administration and resources.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest regarding this work. We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

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DECLARATION

Ethics approval and consent to participate not applicable.

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5. ‖ GENERAL DISCUSSION

As each paper includes its own discussion, it now remains primarily a general comment focused on the answers to the research questions posed in the introduction.

Q1: Is there a definition of telenursing generally accepted by the academic world?

In this sense, there seems to be a certain tendency to consider that telenursing needs to incorporate computerised systems in order to be considered as such. The survey of publications (included in section 4.1) using the word «telenursing» over the decades shows that, in reality, computerised systems have been used in only 8% of cases (corresponding to 16% of the cases in which the methodology used in telenursing is reported). So the question shifts to what are considered Information and Communications Technologies (ICT). If words such as electronic or computer are included in their definition, then it is clear that many published works on telenursing could not be titled as such. It is preferable to consider a more general definition such as «all technical means used to handle information and aid communication», as proposed by the European Commission.[6] In addition, there might be other technical methods in the future that do not use computers, but different and more advanced systems. Thus, any form of transmitting information is valid, including the analogue telephone, used in early reports, Even Morse signals made with a flashlight or transmitting and receiving

[6] Glossary: Information and Communication Technologies (electronic resource), available at:
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Information_and_communication_technology_(ICT) (accessed on 5 December 2023).

messages manually using flags (semaphore). Keeping the definition simple has advantages in reconciling the methods of the past and those that may come in the future, providing remote nursing care by any ICT method.

Q2: What is the state of the art of telenursing according to published research?

Collecting this information has been a lengthy and tedious work. To the already complex task of reviewing more than half a thousand publications was added the need to find the location where the research work had been carried out. In many cases this required an additional search for the location of the centre or the city as, not infrequently, no country data were included. The search for the method of telenursing used was also very complex and it is remarkable that almost half of the publications do not specify this key information. This is a shortcoming that should be corrected in the future. The choropleth map shows surprising facts such as the lack of telenursing publications in many developed countries, the surprising high scientific output of Iran, and the majority use of the telephone as a communication technique.

Q3: is it possible to create and validate a questionnaire for the assessment of alignment of nurses with telenursing, analysing separately the domains of usefulness, acceptance, and appropriateness?

Considering that the survey in this paper was designed and the questionnaire administered in the COVID-19 pandemic period, it was imperative not to overburden the nursing staff with a lengthy survey, which, as stated in the corresponding published paper, is in any case, not recommended. The idea was to design a questionnaire that could be completed in less than 10 minutes. Furthermore, during the Delphi process it became clear that three

domains should be included, and on the other hand, each domain should include at least three paired questions. These paired questions have served to give consistency to the answers. Overall it resulted in a questionnaire with 18 polytomous questions to which a dichotomous question per domain was added, making a total of 21 questions. The questionnaire was translated into Spanish, Polish, Portuguese (including Brazilian variant), although in the end the responses from this latter country were scarce and it was decided not to include them in order to be able to refer the results to Europe.

Q4: Is it possible to test it with different response profiles to assess its consistency?

The tests carried out with computer-generated results were satisfactory, including theoretical variants of more responses against, more in favour and neutral positions, i.e., different profiles of answers.

Q5: Once the questionnaire has been theoretically validated, is it feasible to administer it in a selection of EU countries? If so, what are the results?

The questionnaire was administered in three European countries. The results showed a favourable position of the nursing staff towards telenursing in all three domains. It is striking that when asked what percentage of their work they consider could be done by telenursing, including a holistic view of professional activities, the averaged result was only 34.3%. This confirms that nurses consider nursing care mostly face-to-face care.

Q6: Can remote methods be used as an aid to nursing supervisors? In our case, is it possible to use a remote method

to obtain information from the nursing labour environment that will be useful for nursing management?

The idea, which stems from a previous doctoral project, is to use the publications of nursing staff to monitor various aspects useful for the supervision and management of health care teams. The COVID-19 pandemic provided a unique opportunity to use such a method to assess changes in the work climate. As noted in the foreword, the work that seemed a priori likely to be published most quickly was the one that found the fewest expert reviewers to the point of changing the entire format of this research. It has also caused a considerable delay in the progress of this research. This work is framed within the new techniques of bibliometrics, which consist of analysing data obtained from publications of a given period or topic using statistical methodology. Obviously, analysis through publications has a delay because they take some time to be published but, in contrast, it has the advantage that any topic can be analysed and does not require the administration of questionnaires, which in some cases, such as the COVID-19 pandemic, would have represented an additional effort to the already exhausted forces of the nursing staff.

6. ‖ FINAL CONCLUSIONS

The future development of telenursing is not only a matter of keeping up with the unstoppable global advance of ICT, but also an essential tool for expanding the delivery of care to the population without losing sight of the holistic care that nurses have been striving for over years. It will also facilitate the retention of baby boom nurses and other well-trained professionals, who for a variety of reasons, including pregnancy, are not working or plan to retire early and who are a very important asset to be retained (Gan, 2020; Quinn, 2016). Telenursing can play a key role in this, and hopefully this work can make a contribution to that end.

It is not necessary for a telenursing programme to start with a complex computer system that allows for comprehensive patient care, management, quality control and includes a decision tree. Dedicating a few hours of professional activity to telephone (and/or video telephonic) nursing care through an appropriately designed programme, could be a perfectly reasonable start. The review of published papers confirms that this approach is the most frequently used.

This research fills a gap, as there has not been a general approach, particularly covering several countries, to the position of nurses on telenursing. A surprising gap because, while considering the available patient surveys as very valuable, the professionals' point of view should have been considered important as well. The questionnaire, now available in three languages, fills this previously existing gap. The results of the survey in three European countries show that, although the position of nurses in relation to telenursing

is positive, professionals consider that most care is required to be face-to-face.

In this research, in addition to the original questionnaire and survey research, extensive use has been made of literature analysis, both for work on the state of the art of telenursing and work climate. Advanced bibliometric analysis, combined with artificial intelligence, can be a very useful tool in the future.

7. RESUMEN GLOBAL AMPLIO [7]

7.1. Introducción.

El formato de esta tesis es poco habitual, porque pretende conciliar distintas normativas. Por un lado la idea desarrollada durante los dos primeros años de esta investigación de presentar una tesis por compendio de publicaciones. Sorprendentemente, el tercer artículo (ahora quinto) se retrasó muchos meses por falta de expertos para valorarlo y la fecha límite para la presentación de la tesis se acercaba peligrosamente. Por ello se decidió un cambio de formato para adaptarse a la normativa de tesis por disertación, sin perder la esperanza de que, en el último minuto, pudiese presentarse en la modalidad por compendio, caso de ser aceptados alguno de los dos artículos adicionales que se añadieron a tal fin. Además, la mención internacional requiere en la práctica presentar la investigación en un idioma científico extranjero y ello a su vez requiere incluir un resumen amplio en una lengua oficial de España. El resultado es este trabajo.

La transformación digital ha representado una auténtica revolución, hasta el punto de que se está ya hablando de una nueva era digital (Dreyer et al., 2006), en un mundo que está cada vez más conectado globalmente. Existe la esperanza de que tal vez esa interconexión pueda llevar a una cooperación para resolver los problemas globales, aumentar la actividad comercial, la productividad, los beneficios, la competencia entre conocimientos y tecnología, una mayor participación ciudadana en la toma de decisiones, así como mejoras en los servicios públicos, en la enseñanza y en la ciencia (The World Bank, 2016).

[7] Este resumen tiene 7.999 palabras.

Frente al creciente uso del internet de las cosas (IoT) en la vida cotidiana con smartphones que pueden conectar a distancia una alarma o un electrodoméstico, esta tecnología se encuentra aún en estado embrionario en su aplicación a los cuidados de enfermería (Mieronkoski et al., 2017; Ou et al., 2021; Wang et al., 2021). Pero como se verá a lo largo de este trabajo, esto no es un inconveniente para comenzar un programa de teleenfermería.

Asimismo, en lo que se refiere al teletrabajo en general, que se extendió durante la pandemia de COVID-19, en muchos casos para quedarse de forma permanente, los cuidados de enfermería a distancia se han desarrollado incompletamente, entre otras cosas por el aspecto legal del uso de tales tecnologías digitales y el riesgo de una violación de la seguridad de los datos cibernéticos, entre otras limitaciones (Haghi Kashani et al., 2021; Khan & Salah, 2018; Kumar & Snooks, 2011; Stoyanova et al., 2020; Tsiknas et al., 2021). Hay algunas afortunadas excepciones como la del Colegio de Enfermería de Ontario que ya ha publicado una guía práctica de teleenfermería (Collegue of Nurses of Ontario, 2020). La enseñanza de teleenfermería será un requerimiento imprescindible para las enfermeras del futuro (Gallagher-Lepak et al., 2009; Gibson et al., 2021; Rutledge & Gustin, 2021).

La presente investigación se centra en la enfermería clínica, esto es en la que interactúa con los pacientes. Las posibilidades de usar tecnologías a distancia en la gestión de enfermería no difieren de cualquier otra área de la gestión, y los modelos de aprendizaje y simulación están también bien desarrollados, por lo que estas áreas se han considerado fuera del ámbito de aplicación de esta tesis (Asimakopoulou, 2020; Gallagher-Lepak et al., 2009; Gibson et al., 2021; Rystedt & Lindström, 2001); aunque el quinto artículo

se aproxima a la gestión, pero lo hace todavía con un enfoque predominantemente pensado en la supervisión de enfermería.

Sin entrar en un debate conceptual poco fértil, la teleenfermería (clínica) se define para esta investigación como cualquier prestación de cuidados de enfermería a distancia, ya sea en atención hospitalaria, atención primaria o residencias de ancianos, incluido el uso de cualquier procedimiento, dispositivo o sistema que contribuya directamente a dichos cuidados. Sin embargo, y aunque etimológicamente teleenfermería implica cualquier tipo de atención a distancia (incluido el correo postal), suele referirse a la atención que se proporciona a través de algún sistema de TIC (incluido el teléfono, el chat o la mensajería) (Souza-Junior et al., 2016).

Así, la teleenfermería puede abarcar desde el envío de datos de laboratorio por correo electrónico, o el uso habitual de la atención telefónica (Imlach et al., 2020; Raphael et al., 2016; Souza-Junior et al., 2016), hasta el uso de video-conexiones mediante computador, para la monitorización o evaluación a distancia, incluyendo aplicaciones o terminales con diseños tecnológicos complejos (Kumar & Snooks, 2011; Vijayalakshmi et al., 2020). Esto trae el tema, no exento de polémica, de quién empleará estos dispositivos a distancia al otro lado. Existe una tendencia a considerar, particularmente en áreas apartadas y rurales, la posibilidad de incorporar ‘telepresentadores’, esto es operadores con una formación básica, o incluso robots (Sarder et al., 2017; Sikka et al., 2021). La teleenfermería debería ser capaz de incluir cualquier aspecto de los cuidados integrales de enfermería.

Así, cualquier dispositivo que permita, por ejemplo la monitorización a distancia de la administración de medicación debería considerarse como un dispositivo de teleenfermería,

aunque también pueda proporcionar una información de gestión y control de la provisión de cuidados. En algunos casos, intentar establecer una división entre los sistemas de gestión y prestación de cuidados puede no ser fácil.

La provisión de cuidados aquí se ha contemplado desde el punto de vista holístico y, en consecuencia, no se limita a los aspectos físicos solo, sino que incluye las vertientes social, psicológica y espiritual, en tanto que entren en el campo competencial de la enfermería (Carius et al., 2016; Papathanasiou et al., 2013). Se espera que la teleenfermería aumente el tiempo dedicado a cada paciente, que ahora es escaso, y disminuya el tiempo de inactividad entre procedimientos que ahora supone un porcentaje apreciable (Westbrook et al., 2011; Yen et al., 2018).

Hay cuatro factores clave que impulsan la rápida expansión de las TIC en la atención virtual: i/ Los avances tecnológicos, sobre todo en informática sanitaria (Dreyer et al., 2006; Matsushita, 2020) que contribuyen a una mejor sistematización, control de calidad y autoevaluación de los cuidados (Johnson et al., 2015; Rysst-Gustafsson & Eriksson, 2021; Schuelke et al., 2019); ii/ una demanda social de equidad de acceso (Richard et al., 2016) y de prestar mayor atención al envejecimiento de la población y a quienes viven en zonas remotas (Llorent-Bedmar et al., 2021); iii/ la escasez de mano de obra de personal de enfermería y matronas, que se prevé que empeore en los próximos años (Buchan et al., 2022), y iv/ mejoras de la relación coste-eficacia (Grustam et al., 2018; Hagan et al., 2000).

Si bien es cierto que muchas actividades laborales se realizaron a distancia durante la pandemia, y en algunos casos el sistema se ha mantenido después, el teletrabajo, al menos en España, no ha sido promovido de forma persistente y sistemática por los poderes

públicos, lo cual es lógico teniendo en cuenta la elevada tasa de desempleo de la nación y la disponibilidad de millones de parados para incorporarse al trabajo presencial (Belzunegui-Eraso & Erro-Garcés, 2020; Villanueva & Cárdenas, 2021).

Pero el panorama es completamente diferente para el personal sanitario en general y para la enfermería en particular (Buchan & Aiken, 2008; World Health Organization, 2013, 2016). Ya antes de la pandemia había una escasez de unos cinco millones de titulados en enfermería en el mundo, sin contar que los que tienen más de 55 años de edad (la generación del baby boom) se retirarán en una década, lo que puede añadir otro déficit de magnitud similar. Además, la pandemia ha causado el abandono de un millón de profesionales, así que nos aproximamos rápidamente a una cifra de carencia de unos 7 millones (ICNM - International Centre on Nurse Migration, 2022; Radner, 1998). Esto es un problema que afecta también a los países desarrollados y requiere una acción urgente (Baker & Kim, 2004; Buchan & Aiken, 2008; Einhellig et al., 2020; Marć et al., 2019; Park & Yu, 2019).

El desarrollo futuro de la teleenfermería no es sólo una cuestión de seguir el imparable avance global de las TIC, sino también una herramienta esencial para ampliar la prestación de cuidados a la población sin perder de vista la atención integral por la que los profesionales llevamos años esforzándonos. También facilitará la retención de profesionales del baby boom y otros bien formados, que por diversas razones, entre ellas el embarazo, no están en activo o tienen previsto jubilarse anticipadamente y que constituyen un activo importantísimo que hay que conservar (Gan, 2020; Quinn, 2016). La teleenfermería puede desempeñar un papel clave en este sentido y espero que este trabajo pueda contribuir a ello.

7.2. Objetivos.

Esta investigación se ha planteado con cuatro objetivos principales: 1/ Una revisión del estado del arte de la teleenfermería, analizando lo qué se ha publicado sobre el tema, qué tecnología de comunicación se ha utilizado, y qué definición de teleenfermería se puede obtener de estos trabajos publicados. 2/ Diseñar un cuestionario específico para analizar la opinión de la enfermería clínica sobre la teleenfermería. 3/ Probar el cuestionario en la práctica y obtener resultados a través de valoraciones reales sobre su uso por parte de estos profesionales. 4/ Explorar la posibilidad de utilizar metodología indirecta para analizar otros aspectos del trabajo de enfermería, tomando como ejemplo el clima laboral

En el estado del arte de la tesis (primera publicación) se aborda un aspecto global de investigación: ¿Cuál es la posición de la enfermería clínica con relación a la teleenfermería? que se puede dividir en una serie de preguntas de investigación más específicas, abordadas en las correspondientes a las secciones del texto: La sección 4.1 responde a dos preguntas: **P1:** ¿Existe una definición de teleenfermería generalmente aceptada en el mundo académico? **P2**: ¿Cuál es el estado del arte de la teleenfermería según las investigaciones publicadas?

Las siguientes tres secciones (4.2–4.4) forman una tríada que aborda el objetivo de obtener información y a aliviar la ausencia de datos previos sobre las opiniones en relación con la teleenfermería, incluidos los profesionales que aún no trabajan con teleenfermería, pero también los que ya lo hacen.

Sorprendentemente, hasta ahora no se había diseñado ningún cuestionario específico para conocer la opinión de la enfermería clínica sobre la teleenfermería, ni se habían publicado sus opiniones sobre el alcance de su uso con una visión holística. El

primer obstáculo fue pues que no existían cuestionarios ad hoc y además, los cuestionarios que podrían servir de referencia, basados en la aceptación de la tecnología, ampliamente utilizados para valorar la incorporación de algunos avances como el correo electrónico a la vida profesional, tienen sesgos considerables, y a menudo incluyen preguntas capciosas (Davis, 1993; Lewis, 2018; Venkatesh & Bala, 2008). Sí es cierto que existen trabajos parciales de teleenfermería sobre áreas concretas de especialización, principalmente mediante el uso del teléfono (Holmström et al., 2021; Kaminsky et al., 2020; Kumar & Snooks, 2011; Paolilli et al., 2007; Pourbalouch et al., 2020; Snooks et al., 2008) y encuestas desde el punto de vista de los pacientes (Mattisson et al., 2019). Los cambios organizativos en la sanidad se han caracterizado generalmente por planteamientos que surgen de los niveles superiores de la dirección, para luego ir descendiendo, lo que si no suele ser bien aceptado en las organizaciones en general, lo es aún menos en una comunidad profesional cualificada. El resultado es que, frecuentemente, los procesos no avanzan y se producen perturbaciones y disfuncionalidades. La participación del personal es esencial para garantizar el éxito del cambio (Erlingsdottir et al., 2018).

Los objetivos aquí buscan dar respuesta a las preguntas de investigación: **P3**: ¿es posible crear y validar un cuestionario para medir el posicionamiento de la enfermería clínica con relación a la teleenfermería, analizando por separado los dominios de utilidad, aceptación y adecuación? **P4**: ¿Es posible probarlo con diferentes perfiles de respuesta para evaluar su solidez? **P5**: Una vez validado teóricamente el cuestionario, ¿es factible usarlo en una encuesta en una selección de países de la UE? Si es así, cuáles son los resultados?

Como era de esperar, dada la escasez de variables dicotómicas en la muestra, los resultados de Rasch de tres variables no fueron concluyentes, por lo que se realizó un nuevo trabajo de transformación de las variables politómicas en variables dicotómicas, permitiendo analizar toda la muestra con el Rash. metodología. Los resultados se presentan en la sección 4.4.

La última sección 4.5 presenta la investigación sobre el uso de la tecnología remota para la gestión de enfermería analizando la evolución de temas de tendencia seleccionados (protección personal, malestar psicológico, práctica asistencial y gestión organizativa) en tres entornos principales de trabajo de enfermería: atención primaria u hospitalaria y enfermería. hogares, antes, durante y después de la pandemia de COVID-19 (2019-2022). La pregunta de investigación aquí es: **P6**: ¿Se pueden utilizar los métodos remotos como ayuda para la supervisión de enfermería? En nuestro caso, ¿es posible utilizar un método remoto para obtener información del entorno laboral de enfermería que sea útil para la gestión de enfermería? Al mismo tiempo, es un homenaje a la labor de todos los profesionales sanitarios que se han enfrentado, y en ocasiones han perdido la vida, en la pandemia.[8]

7.3. Metodología.

En el primer trabajo se revisaron todas las publicaciones que contienen la palabra teleenfermería en el título, analizando aspectos como la definición, la extensión geográfica de los programas de teleenfermería y muchas otras cuestiones que se comentan en el cuerpo principal de esta tesis, utilizando la potencia del buscador *Trobes* de esta universidad, que permite acceder a 16 bibliotecas/archivos, 8.084 revistas de salud, 155 bases de datos,

[8] Entre ellos el Dr. Javier Marco Franco, hermano del autor.

incluidas prácticamente todas las utilizadas en ciencias de la salud. También permite recuperar publicaciones de texto completo a través de un cuadro de búsqueda único y personalizable. Se ha creado una base de datos con los resultados de la búsqueda y se han obtenido varios datos mediante funciones condicionales (CONTAR.SI).

Implantar un programa de teleenfermería representa siempre un reto organizacional. Cualquier nuevo proyecto organizacional de desarrollo innovativo implica analizar el impacto de los trabajadores y este impacto puede analizarse desde distintas vertientes (Razali & Vrontis, 2010; Rummler & Brache, 2013; Rutledge & Gustin, 2021).

Por eso, los siguientes trabajos forman una tríada que pretende crear, comprobar y demostrar la validez de un cuestionario que valore la teleenfermería desde el punto de vista del profesional. El progreso del diseño del cuestionario se llevó a cabo en cinco fases: 1/ revisión específica de la literatura; 2/ constructo; 3/ desarrollo de dominios; 4/ desarrollo de ítems (preguntas); 5/ testeo y validación (Kitchenham & Pfleeger, 2002; Parmanto et al., 2016).

La revisión de la literatura sobre cuestionarios ad hoc evidenció experiencias previas interesantes como la escala de usabilidad de sistemas (SUS) (Lewis, 2018), los modelos de aceptación de la tecnología (TAM) (Davis, 1993; Venkatesh & Bala, 2008). También resultó útil el cuestionario de interacción y satisfacción con la teleenfermería (Mattisson et al., 2019) porque aunque está orientado al paciente puede ser utilizado para encontrar preguntas inversas que permitan analizar el punto de vista del profesional.

Inicialmente se creó una bolsa de preguntas obtenida por las aportaciones y sugerencias de los autores de forma independiente, siguiendo un método similar al Delphi, y los textos se reformularon

siguiendo a los grados Flesh-Kincaid en cuanto a su complejidad y nivel de comprensión (Bakken et al., 2006; Solnyshkina et al., 2017). Tras la primera ronda se obtuvieron 49 preguntas.

Sobre esta base de datos preliminar se realizó una selección de dominios. De los datos disponibles en las referencias señaladas arriba se vio necesario explorar tres ámbitos básicos:

- Utilidad percibida
- Aceptación prospectiva
- Adecuación a las tareas de enfermería

En esta fase también se analizó la dimensión (número de preguntas) de la encuesta y la metodología estadística. El tipo de variables se diseñó teniendo en cuenta el posterior procesamiento estadístico planificado: Análisis descriptivo, Teoría Clásica del Test (CTT) y Teoría de Respuesta al Ítem (IRT) mediante un análisis Rasch. Este último método es potente para la validación de las preguntas de una encuesta, pero requiere, salvo para las pruebas de fiabilidad, variables dicotómicas o bien desarrollos computacionales muy complejos, de los que no se han encontrado modelos de aplicación. Por ello se optó por una solución mixta, con preguntas politómicas Likert, que en el campo de las encuestas está muy bien desarrollado, y preguntas dicotómicas para poder emplear la metodología Rasch. La longitud del cuestionario —y, por consiguiente, el tiempo estimado para completarlo— se seleccionó cuidadosamente siguiendo el principio recomendado de «cuanto más corto, mejor» (Amaresan, 2021; Hopper, 2017; Taylor, 2018). Puesto que se había decidido que las preguntas fueran emparejadas para evitar preguntas capciosas, y se requieren al menos tres preguntas diferentes por ámbito, se estableció un formato de seis preguntas (tres pares) por cada uno de dichos ámbitos de utilidad, aceptación y adecuación, resultando un total, en cuanto a las preguntas politómicas, de 18 preguntas (Fan & Yin,

2003; Flake & Fried, 2020; Krosnick & Presser, 2010). También se incluyó una pregunta adicional dicotómica por cada ámbito. Desde el primer momento se tuvo claro que la utilidad principal de éstas cuestiones era fundamentalmente comprobar la consistencia de las respuestas politómicas, dado que, evidentemente, un total de tres preguntas dicotómicas por encuestado no permite realizar un análisis Rasch completo. Para la selección final, partiendo de 49 preseleccionadas se realizaron varias rondas de exclusión de preguntas menos relevantes, hasta quedar las 21 previstas (18 + 3) en las que hubo acuerdo completo entre los coautores (el cuestionario se incluye en el apéndice I). Se estimó un tiempo para responder a la encuesta de 7 min.

Una vez que las preguntas habían sido seleccionadas con sus pares opuestos se procedió a mezclarlas aleatoriamente, siguiendo un generador online de números aleatorios, resultado la distribución que se presenta en la tabla siguiente:

Tabla 7.3.1
Aleatorización de las variables realizada antes de generar el test.

	Politómicas		
	Utilidad	**Aceptación**	**Adecuación**
	18	4	17
	-8	-14	-10
	5	2	15
	-3	-19	-11
	21	12	20
	-13	-16	-6
Dicotómicas	1	7	9

Nota: Las preguntas con signo negativo deben ser invertidas antes del análisis estadístico (1 = 5, 2 = 4, etc.).

Se adaptaron los cuestionarios a las particularidades de los países (por ejemplo en Portugal no hay auxiliares de clínica), se volcaron en un formulario digital (*https://docs.google.com/forms*), aunque

algún centro solicitó la versión escrita y también se empleó este formato en papel.

Este procedimiento implica que una vez obtenidos los datos, antes de procesar los resultados deben volverse a ordenar las variables para que cada una ocupe el lugar que le corresponde.

La inconsistencia en las respuestas se ha medido mediante la comparación de las variables dicotómicas de cada ámbito y su valor teórico (D_t) resultante de la suma de las variables Likert para cada ámbito, con la fórmula aplicada a la hoja de cálculo:

$$SI(SUMA(x{:}y) \geq 15;1;0)^{9}$$

Donde *x:y* representa la suma de las seis variables politómicas por cada ámbito. Si la suma es igual o superior a 15, la respuesta concordante de la variable dicotómica debe ser 1, mientras que si es inferior la respuesta debería ser 0. Así se han descartado aquellos casos donde se presentaron dos o más inconsistencias. La inconsistencia también se ha comprobado con el método Rasch.

Para efectuar la primera validación teórica, y poder considerar todas las posibles tendencias de respuestas, es decir todos los posibles escenarios (mayoría a favor de la teleenfermería, en contra o sin sesgo y a su vez con coherencia e, incoherencia), se generaron por ordenador seis bases de datos distintas, con 120 encuestados ficticios para cada una de esas bases, representando los distintos perfiles. Se estableció un nivel de asimetría, de (2/3) para el caso de desvíos a favor o en contra, y un número igual de respuestas a favor y en contra en el caso de la opción neutra. Cada diseño incluyó a su vez dos variantes: respuestas bien emparejadas (rango de diferencia entre pares [–1 a +1]) y

[9] Nótese que hay un error de edición en el artículo publicado y falta el 1 antes del 15.

respuestas mal emparejadas (diferencia entre pares [–2 a +2]). La siguiente tabla resume las características de estas bases de datos generadas por computación:

Tabla 7.3.2
Características de las bases de datos generadas por computadora

Código	Simetría	Emparejamiento
Fic R + NO	Positiva	Pobre
Fic R + Rel	Positiva	Bueno
Fic Sym NO	Central	Pobre
Fic Sym Rel	Central	Bueno
Fic L - NO	Negativa	Pobre
Fic L - Rel	Negativa	Bueno

Los datos se generaron mediante combinaciones complejas anidadas de aleatorio y condicional (si). De forma que una vez generada aleatoriamente la primera variable (1−5) la variable pareada cumple la condición de estar en el rango de ± 1 o ± 2 según el caso.

La siguiente instrucción es un ejemplo para la variable pareada

=SI(A103=5;(A103+ALEATORIO.ENTRE(-2;0));SI(A103=4;(A103+ALEATORIO.ENTRE(-2;1));SI(A103=3;(A103+ALEATORIO.ENTRE(-2;2));SI(A103=2;(A103+ALEATORIO.ENTRE(-1;2));SI(A103=1;(A103+ALEATORIO.ENTRE(0;3)))))))

De esta forma se generaron los datos para la validación teórica con las distintas variables de respuestas.

Se emplearon la metodología descriptiva, la teoría clásica del test (CTT) y la teoría de respuesta al ítem (IRT) tal y como se recoge en los correspondientes artículos publicados.

Se generaron automáticamente, los siguientes estadísticos de las variables politómicas para cada una de las bases de datos:

Media

Error típico
Mediana de medianas
Desviación típica
Varianza
Curtosis
Asimetría
Media de las sumas
Número de sujetos
Análogamente, para las variables dicotómicas se computó el porcentaje de respuestas favorables.

Debe tenerse en cuanta que la variable ordinal se ha tratado como numérica y debido a esa restricción. los datos tienen solo un valor limitado (Kampen & Swyngedouw, 2000).

Para las estadísticas de CTT se utilizó el software IBM-SPSS V26

La consistencia interna de cada dimensión se determinó con el estadístico Cronbach alfa:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\Sigma\alpha_k^2}{\alpha_{Total}^2}\right]$$

donde *k* es el número de ítems, $\Sigma\alpha_k^2$ es la varianza del ítem y α_{Total}^2 es la varianza total.

Se ha empleado el alfa de Cronbach no estandarizado basado en el análisis de covarianzas entre los ítems, y no en el formato de ítem estandarizado que explora las correlaciones entre los ítems; en nuestro caso las correlaciones se dan por supuesto, y su efecto en las varianzas. Los intervalos de confianza (IC) del 95% para el alfa de Cronbach se han calculado utilizando los coeficientes de correlación interclase, que resultan idénticos al alfa de Cronbach (cuando se calculan con los modelos de consistencia mixta

bidireccional o de consistencia aleatoria bidireccional). Por lo tanto, también se trata de un IC para alfa.

El análisis de componentes principales se realizó para evaluar la fuerza de la correlación parcial, es decir, cómo se explican los factores (ítems) entre sí, y para comprobar la idoneidad del análisis factorial. Los valores de Kaiser-Meyer-Olkin (KMO) indican la adecuación del muestreo para el análisis factorial y la prueba de esfericidad de Bartlett (método de covarianzas y rotación varimax) analiza si la matriz de correlaciones es la matriz de identidad (hipótesis nula) lo que si no es rechazada el análisis factorial no es apropiado. Un resultado del KMO superior a 0,6 indica que el conjunto de variables está suficientemente relacionado para realizar un análisis factorial.

Se realizó un análisis ANOVA para determinar cómo los distintos parámetros condicionan la suma total de las variables politómicas.

Para la IRT se aplicó el modelo Rasch[10].

Es un modelo estocástico (probabilístico) parte del supuesto de que el atributo que se desea analizar (en nuestro caso el posicionamiento del profesional en relación con la teleenfermería), puede representarse conjuntamente mediante una única dimensión global que incluye conjuntamente las personas encuestadas y los ítems (preguntas). Es decir, permite establecer una regla de dos factores, el primero para la capacidad de la persona y el segundo para la dificultad del ítem, expresados como unidades de probabilidad logarítmica (logits). Es un modelo probabilístico de estructura latente con un uso creciente para la evaluación de encuestas.

[10] Prácticamente todas las referencias mundiales sobre el modelo Rash incluyendo un foro online están disponible en *https://www.rasch.org/rmt/rmt213d.htm* (acceso el 28/2/2023)

El modelo analiza las respuestas de *n* individuos a *i* ítems y la probabilidad de un resultado positivo (favorable, o respuesta correcta) ($X_{ni} = x = 1$) $x \in \{0,1\}$ (dicotómico en el documento original), viene dada por la función logística:

$$P(X_{ni} = 1|\beta_n, \delta_i) = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}}$$

donde β_n representa el primer factor (factor individual o de habilidad del individuo) y δ_i el segundo factor (factor de dificultad del ítem).
Las pruebas de Rasch para datos logísticos dicotómicos son el estándar para los modelos de la familia exponencial y se basa principalmente en la máxima verosimilitud condicional. Esto ofrece la posibilidad de diferentes enfoques para la estimación de la verosimilitud (LE).

Se ha empleado la estimación de la probabilidad media ponderada de Warm (WLE) de las medidas Rasch, pero una revisión de 215 estudios y 23 paquetes de software no mostró diferencias significativas entre las distintas estimaciones de LE (Nicklin & Vitta, 2022). Tanto este estadístico como el ratio de fiabilidad a posteriori (EAP) han sido computados tanto para las variables dicotómicas como para las politómicas.

El análisis de Rasch se realizó con R (paquetes: MASS, eRm, Itm, TAM), obteniendo el cociente de fiabilidad EAP y la estimación de la probabilidad de Warm (WLE) tanto para las variables politómicas como para las dicotómicas.

Los datos recogidos con el análisis Rasch han incluido:

A) Prueba de la razón de verosimilitud de Andersen (LR) para la bondad de ajuste del modelo Rasch.

B) Medición del infit MNSQ (infit-sensible ponderado) y outfit (outfit-sensible ponderado). En el análisis Rasch se refiere a la capacidad

de los datos para ajustarse a un modelo y es un elemento esencial del análisis. Este infit (como media cuadrática) representa al ajuste de los datos a la distribución esperada.

Los valores de infit suelen utilizarse para detectar patrones anómalos en los datos, como respuestas erróneas o respuestas excesivas. Se puede calcular Infit para un ítem o una persona promediando los valores correspondientes.

Los valores outfit, por su parte, se utilizan para evaluar la capacidad predictiva de los datos. Se refieren a los ajustes de los datos a la distribución estructurada por defecto.

Se ha determinado el valor estandarizado (*t*) o valor cuadrático medio (MNSQ) del infit que es la media de los residuos cuadráticos ponderados con su cuadrado medio ponderado (W):

$$\text{infit (MNSQ)} = \frac{\sum_n^N W_{ni} z_{ni}^2}{\sum_n^N W_{ni}}$$

donde *W* es la media cuadrática ponderada y *z* representa el residuo normalizado, que para un individuo *r* y el ítem *q* sería:

$$z_{rq} = \frac{y_{rq}}{\sqrt{P_{rq}\left(1 - P_{rq}\right)}}$$

Los valores aceptables de infit y outfit normalizados (*–t* o *Z*) oscilan entre –1,9 y +1,9. Los datos superiores a 2 son impredecibles. Los datos inferiores a –2 son demasiado predecibles.

C) Las mediciones beta, como se ha indicado, reflejan la habilidad de un individuo para proporcionar una respuesta correcta a un ítem (pregunta en este caso) de dificultad *δ.* Los valores próximos a 0 indican una habilidad adecuada. Se han determinado para cada variable dicotómica:

Beta-D1 (0.95CI)

Beta-D2 (0.95CI)

Beta-D3 (0.95CI)

D) Dffclt y Dscrm son otras medidas de dificultad y discriminación en los análisis de Rasch. Los parámetros de dificultad del ítem (*xsi*) son las estimaciones de la posición del ítem en la escala logit que representa la variable latente. Suponiendo que las respuestas se puntúen de forma que las puntuaciones más bajas ($x = 0$) indiquen posiciones más bajas en la variable latente (por ejemplo, respuesta desfavorable), las estimaciones más bajas de los ítems en la escala logit indican ítems que son más difíciles o que requieren que las personas tengan posiciones relativamente más altas en el constructo (en este caso más a favor de la teleenfermería) para dar una respuesta correcta. Por otra parte, las estimaciones de ítems más altas en la escala logit indican ítems más fáciles o que requieren que las personas tengan posiciones relativamente más bajas en el constructo para dar una respuesta favorable.

Pueden utilizarse para evaluar el nivel de dificultad de un ítem concreto, así como la capacidad de los individuos para responder a diferentes niveles de dificultad. Dffclt es el nivel de dificultad de un ítem concreto; una dificultad adecuada estaría próxima a 0. Dscrm es la capacidad de un individuo para discriminar entre ítems de diferentes niveles de dificultad por lo que valores altos indican una buena discriminación.

E) P(x=1|z=0) es la probabilidad de que una persona con una puntuación *z* de 0 tenga una puntuación *x* de 1. Esta probabilidad viene determinada por el nivel de capacidad de la persona y la dificultad del ítem. Análogamente se han determinado:

D1-P(x = 1|z = 0)

D2-P(x = 1|z = 0)

D3-P(x = 1|z = 0)

La curva característica del ítem (ICC) y la curva de información del ítem (IIC) se utilizan para evaluar la consistencia interna de los datos Rasch. La curva ICC mide la fiabilidad de la medición y evalúa si el instrumento de medición es fiable para medir el constructo deseado. En nuestro caso, la pendiente de la ICC representa en qué medida aumenta la probabilidad de dar una respuesta positiva del profesional a favor de la teleenfermería.

Los desplazamientos hacia la izquierda se deben usualmente a un alto grado de efecto 'techo', lo que significa que los ítems (preguntas) son demasiado fáciles para la mayoría de los encuestados, junto con una distribución desigual de las puntuaciones, lo que resulta en un gran número de encuestados que puntúan al mismo nivel (positivo).

El IIC alcanza su punto máximo en el valor de dificultad (mayor discriminación del ítem). Proporciona información sobre cuánta capacidad del rasgo latente proporciona un ítem. La razón más probable del desplazamiento a la izquierda de las curvas IIC es que las preguntas son demasiado fáciles para los sujetos de la prueba.

La metodología descrita hasta aquí se ha empleado en los tres artículos dedicados a la encuesta. Para un desarrollo completo del análisis Rasch, se procedió a la conversión del valor de la escala Likert en un valor dicotómico, dado a las respuestas 1 o 2 el valor 0, a las 4 o 5 el valor 1 y en el caso de valores neutros (3), se tomó como referencia la variable dicotómica (*D*) del correspondiente dominio.

En cuanto al quinto y último trabajo, el procedimiento de búsqueda y selección de publicaciones se basó en la base de datos SJR (Scimago Journal & Country Rank), que establece un indicador independiente, tras analizar la ponderación de las citas y la centralidad del vector (eigenvector) del gráfico, que permite

determinar la importancia de un nodo en la red. Está diseñado para su uso con redes de referencias complejas y heterogéneas como Scopus, e incluye 30.891 revistas científicas, lo que ofrece ventajas sobre otros procedimientos de búsqueda. A nivel global, las publicaciones con el área temática 'enfermería' a través de SJR arrojaron (2021) 640 revistas. El número máximo de artículos publicados (*N*), se estimó, suponiendo 12 números al año (es decir, un número al mes, lo que da un margen de seguridad adicional, ya que no todas las revistas se publican mensualmente), y una media de 20 artículos por número, resultando ser 640 ● 12 ● 20 = 153.600 publicaciones, al año, es decir, 614.400 artículos, para los cuatro años de estudio. En cualquier caso, dado el tamaño del universo (*N*), la muestra a estudiar (*n*) no varía por una pequeña diferencia en *N*.

Se han utilizado dos criterios para determinar la muestra estadística. El primero es que el universo total de la muestra, es decir, *N* = 614.400 artículos, debe estar representado con un margen de error *d* = 0,05, *p* = *q* = 0,5, intervalo de confianza = 99% (esto es, *Z* = 2,58) y, en consecuencia, la muestra total para ello sería *n* = 665 artículos (166 por año). Adicionalmente se ha buscado que cada año tenga, por sí mismo, una representación con un intervalo de confianza del 85% (*Z* =1,44), Por lo tanto, por año (para *N* = 153.600) resulta una muestra de *n* = 207, lo que significa un total de 828 artículos.

Para estos cálculos se utilizó la fórmula bien establecida.

$$n = \frac{NZ_{\alpha/2}^2 pq}{[d^2(N-1)] + [Z_{\alpha/2}^2 pq]}$$

El marco temporal de la búsqueda fue de enero de 2019 a diciembre de 2022.

La búsqueda de la literatura relevante sobre las condiciones de trabajo de las enfermeras durante la pandemia de COVID-19 se recogió de diferentes bases de datos, PubMed, EBSCO y CINAHL, Embase, Web of science. Las búsquedas se realizaron combinando los términos clave relacionados "nurse", "employment," "working conditions," "health," y "COVID-19." Se utilizó la condición booleana nurs* AND protection OR psychological OR practice OR organization OR management. El primer volcado de datos contenía publicaciones duplicadas. Esto se comprobó mediante una clasificación informatizada A-Z del campo Digital Object Identifier (DOI). Por consiguiente, las referencias duplicadas detectadas de este modo se eliminaron y sustituyeron.

Se exigieron las siguientes condiciones:

I) Cada artículo seleccionado debe permitir un análisis completo mediante el acceso al texto completo de la publicación. Esto no significa necesariamente acceso abierto, sino un acceso a través del inicio de sesión de alguno de los coautores o compra.

II) Debe incluir el identificador digital de objetos (DOI), que permite realizar un control de calidad posterior y volver a consultar el artículo rápidamente en caso necesario.

III) No deben referirse a aspectos relacionados con especialidades concretas, o unidades de enfermería específicas (cardiología, cuidados intensivos, etc.,) y deben aportar datos originales, excluyendo estudios secundarios, revisiones o metaanálisis. Todos los estudios deben referirse a las condiciones de trabajo durante la pandemia de COVID-19, especialmente en relación con la organización por parte de la enfermera de la situación y el entorno de trabajo. Nótese que este enfoque multidimensional se establece para la condición específica de la pandemia de COVID-19, pero

podrían establecerse otras dimensiones para periodos o análisis específicos. Se excluyeron los aspectos relacionados con técnicas de enfermería específicas (generales o especializadas).

El análisis de los artículos incluidos comenzó con la creación de una matriz de categorización formativa con cuatro categorías preestablecidas, basadas en nuestra adaptación de la teoría y las esferas determinantes establecidas en el modelo SwAge (Nilson, 2021; Nilsson, 2020, 2021; Nilsson & Nilsson, 2021).

IV) Siguiendo las revisiones sistemáticas sobre el efecto de la pandemia en la enfermería que demuestran un impacto multidimensional (Beattie et al., 2023; Liang et al., 2021), se seleccionaron los tópicos (temas) agrupando estas múltiples dimensiones en cuatro categorías:

1/ Temas de relacionaos con la protección personal, este factor se relacionó con los temores y amenazas de contagio, los sentimientos de realización que merecen la pena, el desafío, el grado de diversidad e interés en las tareas ocupacionales, el crecimiento y desarrollo personal, el uso de habilidades y la cantidad de independencia y autonomía en el trabajo (Beattie et al., 2023; Guedes Dos Santos et al., 2021; Llop-Gironés et al., 2021).

2/ Aspectos psicológicos, relacionadas con la satisfacción con el trabajo, ‘burnout’ y la interacción con los pacientes (Birt et al., 2023; Fontanini et al., 2021; Gutiérrez-Fernández et al., 2023; Nagel et al., 2022; Saragih et al., 2021; Savitsky et al., 2021).

3/ Aspectos de procedimientos, particularmente relativos a la organización y clima laboral (Buheji & Buhaid, 2020; Giri et al., 2021; Guedes Dos Santos et al., 2021).

4/ Gestión y satisfacción, particularmente, con las condiciones de carga de trabajo, horario, ritmo de trabajo, tiempo de recuperación,

etc. (Birt et al., 2023; Gutiérrez-Fernández et al., 2023; Liang et al., 2021).

En cuanto a las áreas (segunda variable del análisis), éstas se han clasificado en:
A/ enfermería general, atención primaria o no especificada en la publicación.
B/ enfermería hospitalaria.
C/ centros residenciales, residencias de ancianos o similares.
Los datos por temas y áreas se analizaron con estadísticas no paramétricas y se mostraron en formatos gráficos.

7.4. Principales resultados

En cuanto al primer trabajo sobre el estado del arte de la teleenfermería, Se encontraron un total de 624 artículos, pero se detectaron muchas repeticiones consultando el DOI/ISNN. Además, la herramienta de búsqueda seleccionó artículos donde la teleenfermería no estaba incluida en el título y/o no se centraban realmente en la teleenfermería. La selección final incluyó 311 publicaciones.

Las primeras publicaciones encontradas sobre teleenfermería se remontan a 1994 en Dinamarca y a 1995 en EUA. Desde entonces el número de publicaciones ha sido creciente. Notablemente, la mayoría de los trabajos se refieren a cuestiones de organización y revisiones. Los artículos originales con trabajos de campo solo representan el 9% del total. La calidad en general es buena, con revisión por pares en el 72.3%.

Resulta notable que la metodología a distancia utilizada no se especifica casi en la mitad de los casos. Cuando ésta se indica, en el 67,3% se ha utilizado el teléfono. La tecnología computacional representa solo el 16% de los casos en las que se menciona. El

mapa coroplético muestra la distribución por regiones del planeta, siendo los países líderes en publicaciones los EUA, Suecia e Irán.

Por lo que respecta a la tríada de tres trabajos relativos al cuestionario, las estadísticas descriptivas evidencian el adecuado perfil de las distintas bases de datos, que muestran las asimetrías esperadas evidenciadas por su asimetría y curtosis. Se resumen en las siguientes tablas 7.4.1 y 7.4.2.

Tabla 7.4.1
Estadísticas descriptivas de las bases de datos generadas por computación.

Bases de datos	Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel
Datos ($\bar{y}$)	Variables politómicas					
Media de medias	2,87	2,62	3,02	3,00	3,32	3,42
Mediana de medianas	2,75	2,00	3,00	3,00	4,00	4,00
Desviación típica	0,50	0,50	0,47	0,49	0,44	0,44
Varianza	0,25	0,25	0,22	0,24	0,20	0,20
Curtosis	−1,99	−2,02	−1,51	−1,78	−0,83	−0,86
Asimetría	−0,20	0,12	−0,72	−0,50	−1,09	−1,07
Media de las sumas	66,00	56,33	85,00	74,33	88,33	88,00
Numero de sujetos	120	120	120	120	120	120
	Variables categóricas					
Media	0,55	0,47	0,67	0,62	0,74	0,73
Error típico	0,05	0,05	0,04	0,04	0,04	0,04
Respuestas positivas (%)	55,0	46,9	66,7	61,9	73,6	73,3

Nota: Para los detalles de cada base de datos véase tabla 7.3.2.

Tabla 7.4.2
Resultados del alfa de Cronbach-α por cada dominio y base de datos.

Base	Fic R + NO			Fic R + Rel			Fic Sym NO			Fic Sym Rel			Fic L—NO			Fic L—Rel		
Dominio	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap	U	Ac	Ap
Cronb- α	0,84	0,86	0,84	0,94	0,95	0,94	0,83	0,80	0,82	0,94	0,95	0,94	0,82	0,83	0,84	0,94	0,95	0,95
	0,94			0,98			0,93			0,98			0,94			0,98		
95% CI	0,93–0,96			0,91–0,98			0,91–0,95			0,97–0,98			0,92–0,95			0,97–0,98		

Nota: Dominios: U = Utilidad. Ac = Aceptación. Ap = Adecuación.

La tabla 7.4.3 presenta el análisis de componentes principales:

Table 7.4.3
Análisis de componentes principales.

Base datos	Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel
KMO	0,93	0,95	0,94	0,93	0,93	0,94
Bartlett	0,000	0,000	0,000	0,000	0,000	0,000

Como era de esperar, el resultado del coeficiente de fiabilidad (EAP) para los datos dicotómicos obtenido por Rasch (0,70), no resultó tan bueno como el de los datos politómicos (0,94). Sin embargo, el infit-t y el outfit-t de las variables dicotómicas están muy centrados, y los coeficientes de realidad de las variables politómicas, utilizando las estimaciones de probabilidad media ponderada de Warm, son siempre > 0,9.

Esto sugiere que un cuestionario exclusivamente dicotómico no sería tan apropiado como un modelo mixto que incluyera datos politómicos en escala Likert, a menos que la pérdida de información pudiera contrarrestarse con un mayor número de variables categóricas, lo que aumentaría el tiempo de cumplimentación de la encuesta.

El segundo artículo de la tríada, también publicado ya, muestra los resultados de la encuesta que se realizó en países seleccionados (España, Portugal, Polonia) por sus diferentes perfiles económicos dentro de la Unión Europea.

Un dato muy relevante obtenido de este estudio es que el personal de enfermería encuestado considera bastante limitada la aplicabilidad del teletrabajo en la profesión; incluso incluyendo la prestación de cuidados integrados (holísticos), el porcentaje de aplicabilidad obtenido fue del 34,3% (33,5–36,3). En 16 casos (7,1%) se encontraron respuestas poco coherentes y se excluyeron del cómputo.

En cuanto al análisis clásico (CCT), el alfa de Cronbach y las pruebas de KMO y Bartlett confirman la adecuación de los

resultados. En conjunto, el alfa de Cronbach es muy elevado (0,945), con una correlación interclase de 0,945, KMO 0,952 y p<0,001 de la prueba de esfericidad de Bartlett. Los resultados son consistentes para cada dominio por separado (Tabla 7.4.4).

Tabla 7.4.4
Análisis de componentes principales de variables politómicas por dominio y del total.

Dominio	Cronbach alfa	Correlación interclase	Intervalo (95%CI)	KMO	Bartlett
Utilidad	0,785	0,785	0,739-0,826	0,819	<0.001
Aceptación	0,878	0,878	0,851-0,901	0,884	<0.001
Idoneidad	0,883	0,883	0,857-0,905	0,871	<0.001
Total	0,945	0,945	0,934-0,955	0,952	<0,001

Como era de esperar con la metodología de la teoría de respuesta al ítem (IRT), al considerar un constructo con sólo tres variables categóricas, la fiabilidad de la EAP es de 0,52, lo que indica un ajuste insuficiente del modelo de Rasch cuando sólo se incluyen tres variables dicotómicas; esto se confirma por la WLE de –0,49. La verdadera utilidad del análisis IRT se obtiene al utilizar las variables politómicas donde el cociente EAP es de 0,95, lo que indica que la escala de valoración se ajusta muy bien al modelo de Rasch subyacente. La estimación de la probabilidad media ponderada de Warm (WLE), también proporciona una puntuación muy alta (0,94). Para ampliar el análisis IRT se realizó un tercer trabajo de conversión de las variables categóricas en dicotómicas confirmando que el cuestionario es adecuado, si bien la pregunta tres debería reformularse o suprimirse, con o sin su pareada la pregunta cinco.

Lo más remarcable de los resultados del quinto y último trabajo basado en el análisis bibliométrico es que el método fue capaz de demostrar cambios estadísticamente significativos a lo largo del tiempo de estudio, demostrando la sensibilidad del método.

En realidad lo importante aquí era valorar la metodología puesto que, una vez comprobada su utilidad, el método puede ser aplicado fijando criterios de publicación por temas, áreas geográficas, u otros limitadores, buscando cualquier otro tema que pueda resultar de interés. El hecho de usar el clima laboral antes, durante, y después de la pandemia de COVID-19 ha sido solo un ejemplo.

La diferencias de los tópicos a lo largo del tiempo fueron estadísticamente muy significativas (X^2 = 127,5; p= 0,000001)

Tabla 7.4.5
Diferencias de los tópicos a lo largo de los cuatro años (2019 - 2022).

Tópicos ►	**Protección (1)**	**Salud mental (2)**	**Procedimientos (3)**	**Gestión (4)**	
▼ Años	n_1 (%)	n_2 (%)	n_3 (%)	n_4 (%)	
2019	4 (2)	34 (16)	38 (18)	131 (63)	207
2020	15 (7)	56 (27)	30 (14)	106 (51)	207
2021	9 (4)	122 (59)	25 (12)	51 (25)	207
2022	9 (4)	63 (30)	60 (29)	75 (36)	207
X^2= 127,5. p=0,000001	37 (4)	275 (33)	153 (18)	363 (44)	828

Se evidencia un importante aumento en la temática de aspectos psicológicos coincidiendo con el peor momento de la pandemia. El personal prestó menos interés, según reflejan las publicaciones, a los aspectos de gestión.

Las siguientes figuras presentan los datos desglosados por áreas de trabajo. Como se observa en dichas gráficas, el comportamiento fue parecido en atención primaria y hospitalaria, pero en las residencias de ancianos los problemas que más impactaron fueron los relacionados con la gestión y adaptación de los centros a la pandemia.

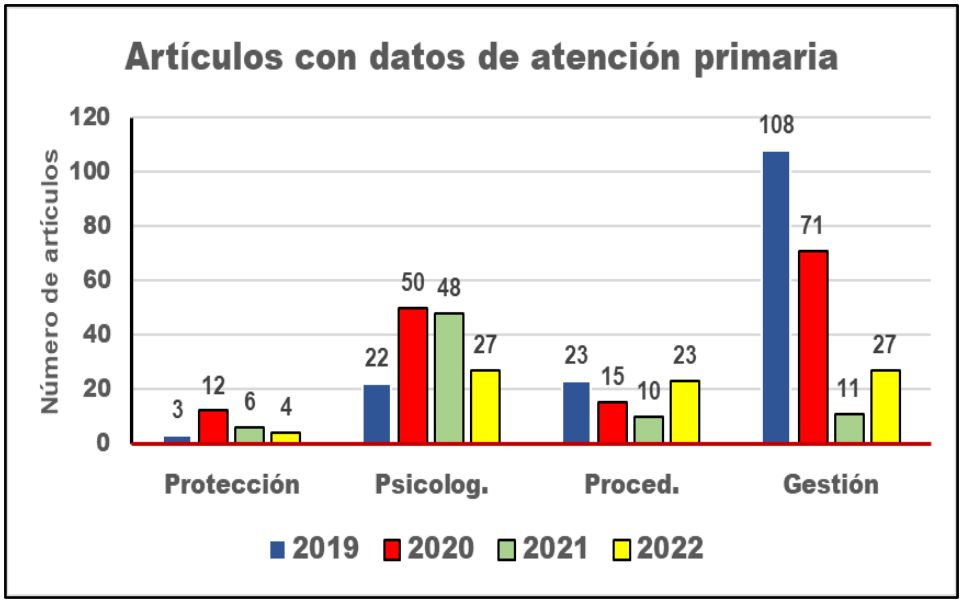

Fig. 7.4.1. Evolución de los temas a lo largo de los años (AP).

En los hospitales los problemas de salud mental aumentan notablemente en 2021 y los artículos relacionados con la gestión se mueven al contrario que en atención primaria.

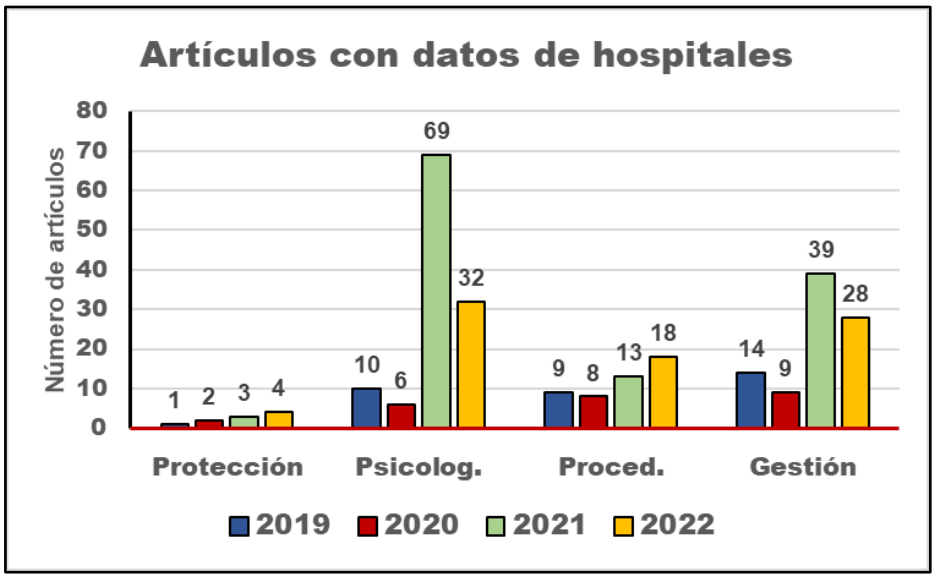

Fig. 7.4.2. Evolución de los temas a lo largo de los años en atención hospitalaria.

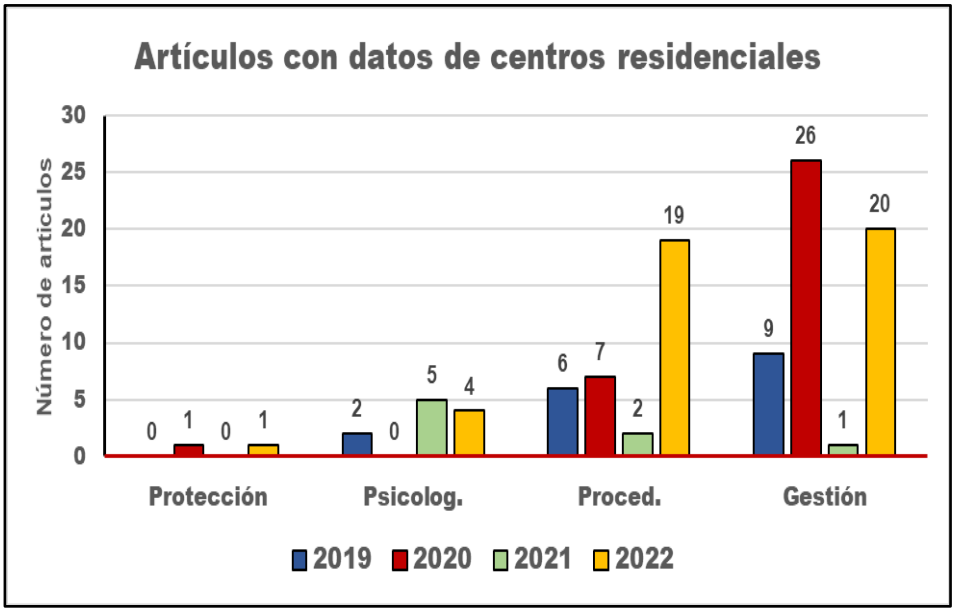

Fig. 7.4.3. Evolución de los temas a lo largo de los años en centros residenciales.

7.5. Conclusiones

Aunque inicialmente pudiera parecer que el concepto de teleenfermería requeriría el uso de sistemas computarizados, el estudio de las publicaciones (analizadas en el primer trabajo) evidencia que, en realidad, los sistemas informatizados se han utilizado sólo en el 8% de los casos (lo que corresponde al 16% de los casos en los que la metodología utilizada en teleenfermería se ha reportado).

La cuestión aquí es entonces, ¿qué se consideran tecnologías de la información y las comunicaciones?

Si se incluyen en su definición palabras como electrónico, digital u ordenador, queda claro que muchos trabajos publicados sobre teleenfermería no podrían titularse como tales. Es preferible considerar una definición más general como “todo medio técnico utilizado para manejar la información y ayudar a la comunicación,” como propone la Comisión Europea. Además, en el futuro podrían

existir otros métodos técnicos que no utilicen ordenadores sino sistemas diferentes y más avanzados.

Lo razonable parece ser el aceptar que se incluya cualquier forma de transmisión de información, incluido el teléfono analógico, utilizado en los primeros artículos; incluso las señales Morse realizadas con luces hacia o desde un barco, o con el código de banderas (semáforo). Mantener la definición simple tiene ventajas al conciliar los métodos del pasado y los que pueden venir en el futuro: Proporcionar atención de enfermería a distancia mediante cualquier método de TIC.

En cuanto a los tres trabajos sobre el cuestionario, tanto el enfoque CTT como el IRT, confirman la validez del diseño de encuesta para evaluar el posicionamiento de las enfermeras en relación con la teleenfermería.

Los análisis mostraron que las variaciones generadas por computación, en las bases de datos presentadas en el artículo primero de la tríada, fueron adecuadamente detectadas por los estadísticos utilizados y que, por tanto, el procedimiento metodológico es sensible a los cambios en el perfil de simetría, curtosis o concordancia entre pares de preguntas. También confirma que la metodología empleada combinando la valoración clásica con la teoría de respuesta al ítem es adecuada.

En lo que respecta al artículo segundo de la tríada, los resultados no son inesperados. La mayoría de los cuidados de enfermería necesitan actividades presenciales, pero aun así, hay una parte sustancial (34,3%) de la actividad que los profesionales en ejercicio consideran que puede ser cubierta por la teleenfermería.

Sin embargo, no es necesario que un programa de teleenfermería comience con un complejo sistema informático que permita la

atención integral al paciente, la gestión, el control de calidad e incluya un árbol de decisiones. Dedicar unas horas de actividad profesional a la atención telefónica (y/o video-telefónica) a través de un programa adecuadamente diseñado en colaboración con enfermería, podría ser un comienzo perfectamente razonable.

En cuanto al tercer artículo, de la tríada, éste permitió confirmar la validez del cuestionario mediante un análisis Rasch adicional y detectar un punto débil mejorable, la pregunta tres.

Este estudio piloto demuestra que el cuestionario sobre teleenfermería es sólido y permite analizar por separado los tres ámbitos (utilidad, aceptabilidad y adecuación o idoneidad).

De este grupo de tres trabajos sobre el cuestionario, se puede concluir que se cumple el objetivo esperado de crear y desarrollar una herramienta de partida para guiar el proceso de cambio hacia la atención remota y reforzar la participación de enfermeras las decisiones de gestión. Los datos, ahora limitados a los tres países de la UE seleccionados se pueden fácilmente ampliar para analizar la cuestión en otros países.

Una quinta y última línea de investigación sobre tecnología a distancia permitió evaluar el clima laboral, mediante el análisis de las publicaciones del personal.

El método se revela como una herramienta útil, que no requiere la administración continua de encuestas. Los datos, una vez recogidos, pueden computarse en múltiples enfoques, incluyendo áreas o temas desagregados a lo largo del tiempo.

El estudio presentado demuestra que el método es sensible a los cambios en el entorno de trabajo, como se detectó a lo largo de la pandemia COVID-19. Los ítems y las áreas pueden variarse en función de los objetivos del estudio.

En esta investigación, además del cuestionario original y de la encuesta, se ha hecho un amplio uso del análisis bibliográfico, tanto para los trabajos sobre el estado del arte de la teleenfermería como sobre el clima laboral. El análisis bibliométrico avanzado, combinado con la inteligencia artificial, puede ser una herramienta muy útil en el futuro.

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9. ‖ APPENDIX I: QUESTIONNAIRES

QUESTIONNAIRE

Instructions on how to complete the multiple-choice questionnaire

This is a study carried out by the universities of Valencia (UV, and UPV, Spain), and Porto (Portugal) to gather the nursing point of view on telenursing. The person in charge of the study is Dr Julio E. Marco Franco (juemar@alumni.uv.es). Any questions you may have can be sent to this e-mail address.

1. This is a voluntary and unpaid questionnaire which is expected to be useful to the nursing community.

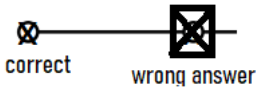
2. This survey is focused on clinical nurses and nurses' assistants only. Nurses involved in management, executive functions, governmental or public health activities, research and teaching should not complete the questionnaire.

3. If you have not had previous experience in telenursing, try to give your opinion in the case of joining a team with such a system, based on your previous experience in telephone patient care and use of digital media (smartphones, email, social networks, music consumption in the cloud, etc.) and your prospective behavioural intention.

4. The results are completely anonymous. There are no good or bad answers. Please answer all questions. Any answer is valid and appropriate. Please tick the answer that most closely matches your opinion. Only one answer per numbered item, please.

5. If you provide the answers in paper format, please mark a single circle with an X to indicate the answer that you think best represents your opinion for each question. Please remember, only one answer out of the five possibilities.

6. If you make a mistake, mark the wrong answer with a square and mark the correct answer as indicated



7. If you answer online, the system will allow you to change the answer. There is no need to answer all the questions at a time. Please take a few days if needed to answer, but please try to answer all questions. Submit the format when ready.

8. Remember that the system will not request or store any personal information; if you log in again from a different computer or smartphone your previous information will be lost.

9. The study follows the Principles of the Declaration of Helsinki (World Medical Association 2013). Data is recorded anonymously without any ID reference. No information reported in this paper can be linked to any individual. The study follows the procedure established by the Ethics Committee of the University of Valencia for these surveys.

10. Thank you very much for your collaboration!

General demographic data (anonymous).

Please do not include any information that could identify yourself.

A. Birth year (xxxx) (year only)

☐☐☐☐

B. Gender

Male..... ☐

Female..... ☐

Other..... ☐

C. Number of years working as a nurse (xx). If you have been working as an auxiliary nurse before, please indicate the full time in the profession..... ☐☐

D. Country. Please mark X.

Spain..... ☐

Portugal..... ☐

Other (indicate)_____ ☐

E. Workplace (If unemployed, please indicate the area in which you have been employed the longest). Please Mark X

Primary and community care nurse..... ☐

Hospital Nurse..... ☐

Nursing home nurse..... ☐

F. (Highest) academic degree. If you have several degrees, please mark only the highest one with an X.

Nursing assistant certificate..... ☐

Nursing school diploma (3 years)..... ☐

Bachelor's degree in nursing (4 years)..... ☐

Master's degree in nursing or health sciences.... ☐

Doctorate in nursing or health sciences..... ☐

G. Speciality in nursing ... YES ☐.....NO.☐

H. Experience using telenursing (total or partial).

I have never used telenursing ..... ☐

Two years or less..... ☐

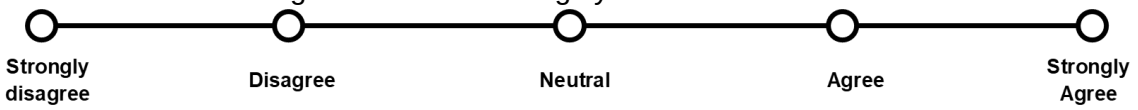
Over two years ..... ☐

Questionnaire

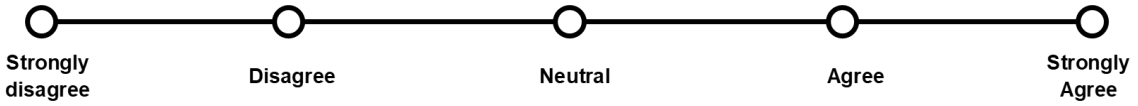
1. In general, I consider telenursing to be.....

useful ☐
useless ☐

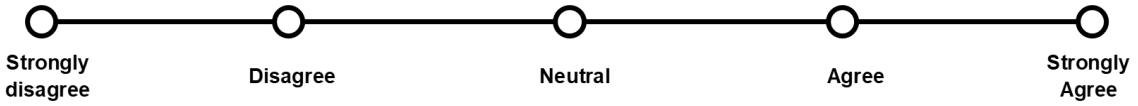
2. I think I will be willing to use a telenursing system.



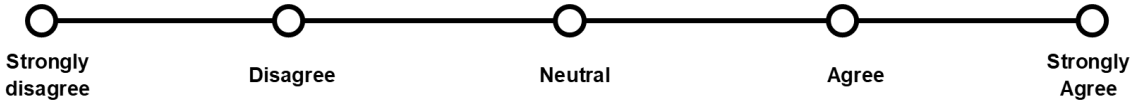
3. I will limit the use of telenursing to only the most basic nursing tasks.



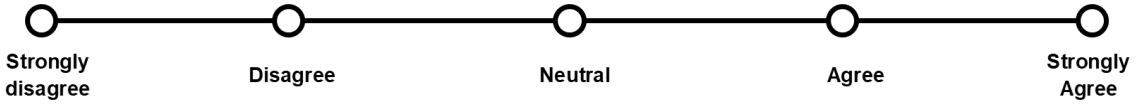
4. I have no problem if the organisation requires me to use telenursing.



5. To the extent possible, I will use telenursing to do different things, clinical or non-clinical.



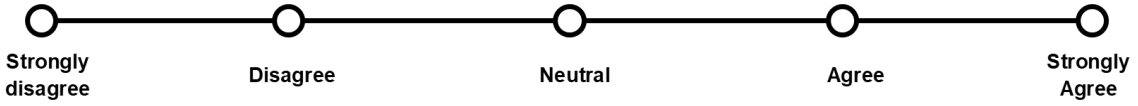
6. Adequate nursing patient care and management cannot be properly provided through the use of telenursing.



7. In general, I consider telenursing .....

acceptable ☐
unacceptable ☐

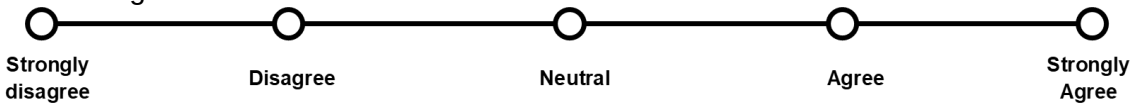
8. I will not use telenursing except if it is mandatory in my work.



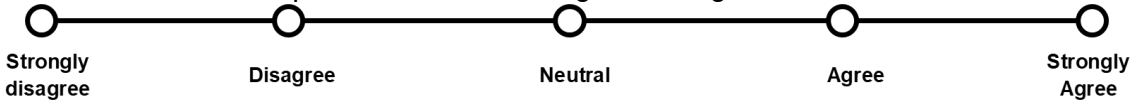
9. For nursing work telenursing systems are.....

inappropriate ☐
appropriate ☐

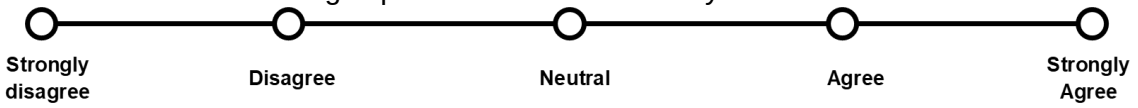
10. It is difficult to manage the health and needs of patients through the use of telenursing.



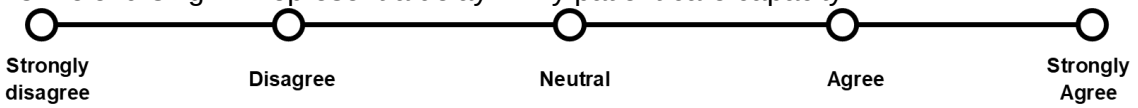
11. I do not see the importance of telenursing in nursing care.



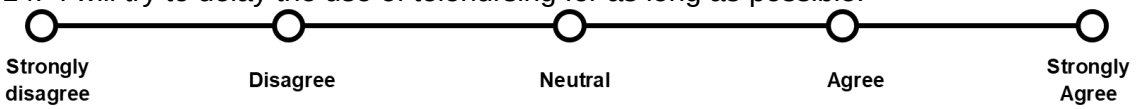
12. The use of telenursing in patient care is satisfactory.



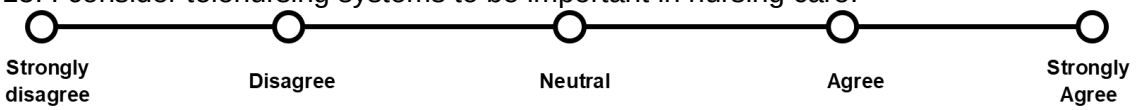
13. Telenursing will represent a delay in my patient care capacity.



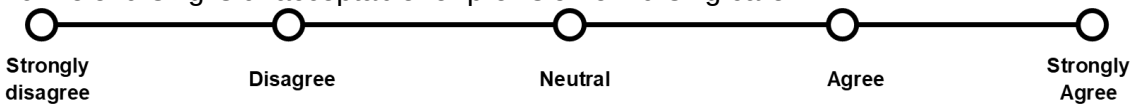
14. I will try to delay the use of telenursing for as long as possible.



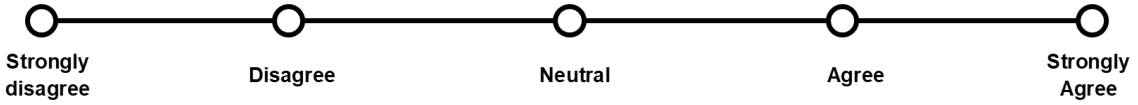
15. I consider telenursing systems to be important in nursing care.



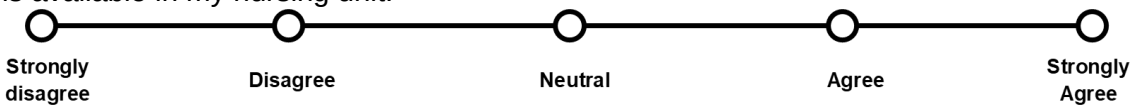
16. Telenursing is unacceptable for provision of nursing care.



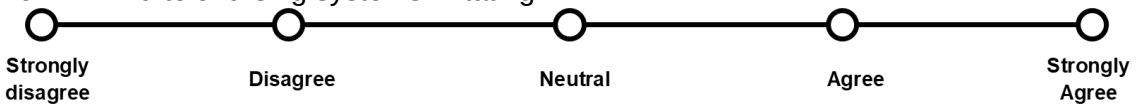
17. Telenursing is an appropriate way to manage health improvement and patients' needs.



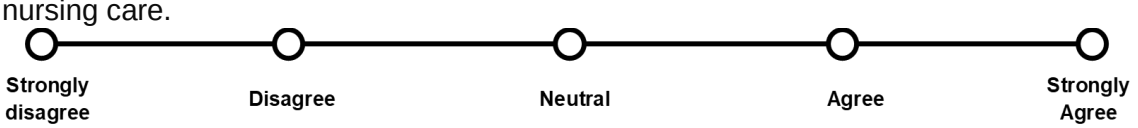
18. I intend to use telenursing technology in patient care and management as soon as it is available in my nursing unit.



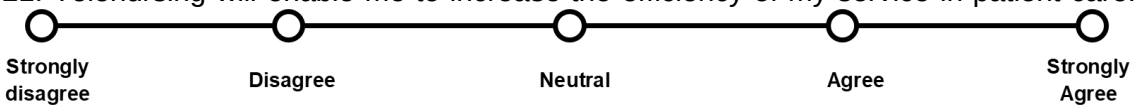
19 I will find telenursing systems irritating.



20 The use of telenursing technology is appropriate for the delivery and management of nursing care.



21. Telenursing will enable me to increase the efficiency of my service in patient care.



22. In a nursing professional development that encompasses the holistic aspects of health care (social, spiritual, psychological, and physical), what percentage of the care activity do you think could be done by telenursing? _____%

CUESTIONARIO

Instrucciones parar rellenar el cuestionario de múltiples opciones

Este es un estudio de las universidades de Valencia (UV y UPV, España) y de Oporto (Portugal) para obtener información sobre teleenfermería desde el punto de vista del personal de enfermería. La persona encargada del estudio es el Dr. Julio E. Marco-Franco (juemar@alumni.uv.es). Puedes enviar a esta dirección electrónica cualquier duda que surja.

1. Esta es una encuesta voluntaria y no remunerada, cuyos resultados se espera que sean de utilizad a la comunidad de enfermería.

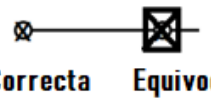
2. La investigación se centra en enfermería/auxiliares del área clínica exclusivamente. El personal de enfermería destinado a la gestión, funciones ejecutivas, actividades gubernamentales o públicas, investigación, o enseñanza no deben completar el cuestionario.

3. Si no has tenido experiencia previa en teleenfermería, intenta dar tu opinión en el caso de incorporarte a un equipo con un sistema de este tipo, basándote en tu experiencia previa en la atención telefónica al paciente y en el uso de medios digitales (smartphones, correo electrónico, redes sociales, consumo de música en la nube, etc.) y en tu intención de comportamiento previsible.

4. Los resultados son completamente anónimos. No hay buenas ni males respuestas. Por favor responde a todas las cuestiones. Cualquier respuesta es válida y apropiada. Por favor marca la respuesta que más se aproxime a tu opinión.

5. Si respondes al cuestionario en papel, por favor marca un solo círculo con una x para indicar la respuesta que crees que representa tu opinión para cada cuestión. Por favor recuerda, solo una respuesta entre las cinco posibilidades:

6. Si cometes un error, enmarca la respuesta equivocada con un cuadrado y vuelve a marcar la pregunta correcta como se indica.



7. Si contestas online, el sistema te permitirá cambiar la respuesta. No hay necesidad de contestar todas las cuestiones de una vez. Por favor tómate unos días si es necesario para contestar, pero por favor trata de contestar todas las cuestiones. Remite el cuestionario cuando esté listo.

8. Recuerda que el sistema no solicitará ni almacenará ninguna información personal; si vuelves a conectarte desde otro ordenador o smartphone, tu información anterior se perderá.

9. El estudio sigue los principios de la Declaración de Helsinki (Asociación Médica Mundial 2013). Los datos se archivan anónimamente sin ninguna referencia de identidad. Ninguna información recogida en este trabajo puede ser vinculada a ningún individuo. El estudio sigue el procedimiento establecido por el Comité de Ética de la Universidad de Valencia para este tipo de encuestas.

10. ¡Muchas gracias por la participación!

Datos demográficos generales (anónimos).

Por favor no incluyas ninguna información que pueda identificarte

A. Año de nacimiento (xxxx) (solo año)

☐☐☐☐

B. Género

Masculino..... ☐

Femenino..... ☐

Otro ..... ☐

C. Número de años trabajando en enfermería (XX) (si has trabajado como auxiliar antes, indica el periodo total en la profesión)..... ☐☐

D. País. Por favor marca X.

España..... ☐

Portugal..... ☐

Otro (indicar)_____ ☐

E. Lugar de trabajo (en caso de desempleo indicar el área donde hayas trabajado más tiempo). Por favor marca X

Atención primaria y comunitaria..... ☐

Atención hospitalaria..... ☐

Centros residenciales ..... ☐

F. Nivel académico (más alto). Si tienes varios títulos marca con X solamente el más alto.

Certificado de auxiliar/técnico de enfermería..... ☐

Diploma en enfermería (ATS/DUE) (3 años) ..... ☐

Grado en enfermería (4 años) ..... ☐

Máster en enfermería o ciencias de la salud..... ☐

Doctorado en enfermería o C. de la salud..... ☐

G. Especialidad en enfermería …SI.☐….NO.☐

H. Experiencia en el uso de teleenfermería (total o parcial)

Nunca he usado teleenfermería..... ☐

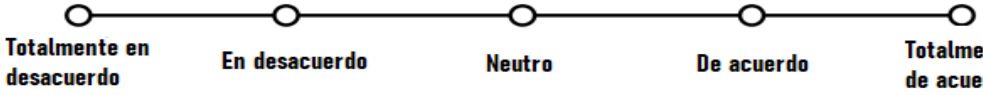
Dos años o menos ..... ☐

Más de dos años ..... ☐

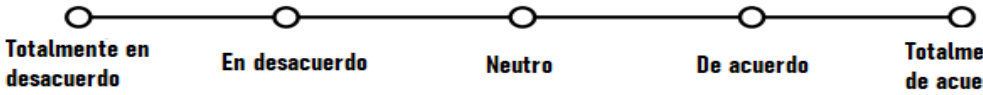
Preguntas

1. En general considero la teleenfermería..... útil ☐ inútil ☐

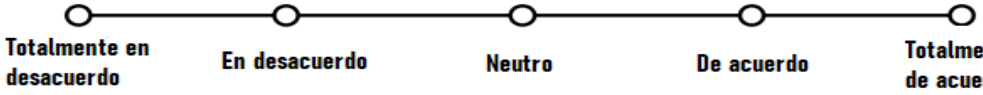
2. Creo que estaré dispuesto/a a utilizar un sistema de teleenfermería.



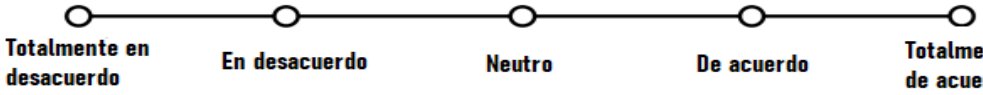
3. Me limitaré a usar la teleenfermería solamente para las tareas más básicas de enfermería.



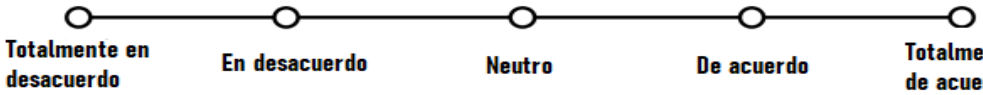
4. No tengo problemas si la organización me requiere a usar la teleenfermería.



5. En la medida de lo posible utilizaré la teleenfermería para hacer diferentes tareas, clínicas y no clínicas.

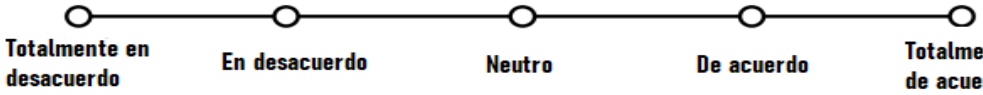


6. No es posible proporcionar un cuidado y gestión adecuados al paciente mediante teleenfermería.



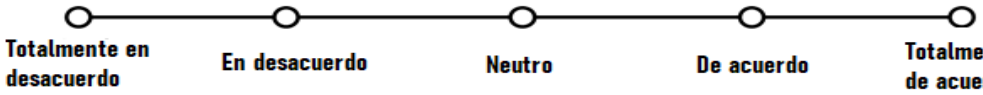
7. En general. Considero la teleenfermería ..... aceptable ☐ inaceptable ☐

8. No usaré la teleenfermería en mi trabajo si no es obligatorio.

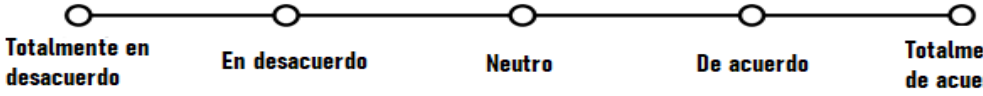


9. Para el trabajo de enfermería los sistemas de teleenfermería son inapropiados ☐ apropiados ☐

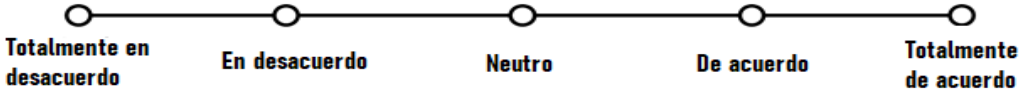
10. Es difícil gestionar la salud y necesidades de los pacientes con teleenfermería.



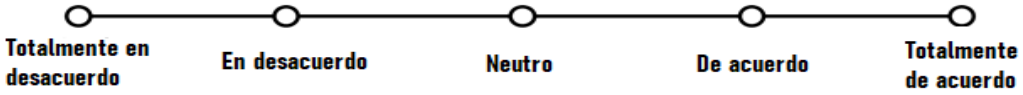
11. No veo la importancia de la teleenfermería en los cuidados de enfermería.



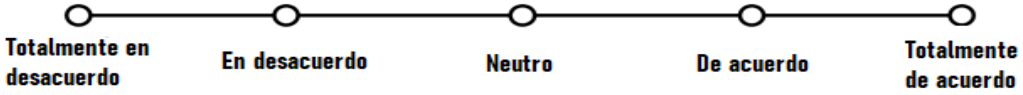
12. El uso de teleenfermería en el cuidado del paciente es satisfactorio.



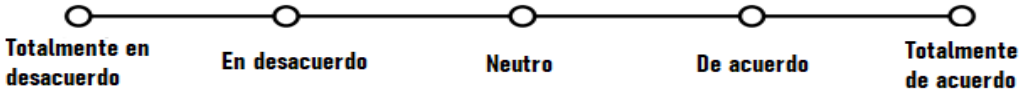
13. La teleenfermería representa un retraso en mi capacidad de atender al paciente.



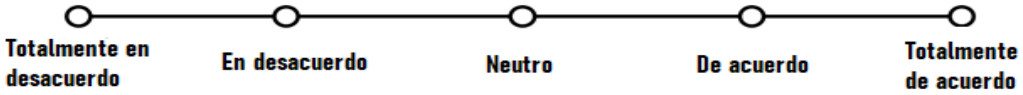
14. Intentaré retrasar el uso de la teleenfermería el mayor tiempo posible.



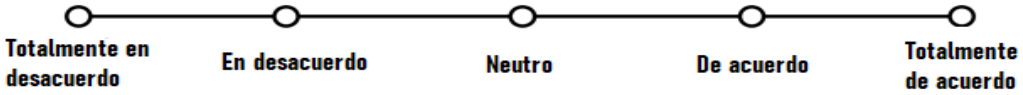
15. Considero que los sistemas de teleenfermería son importantes en los cuidados de enfermería.



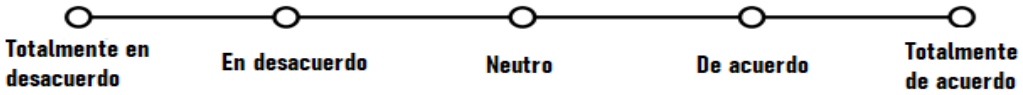
16. La teleenfermería no es aceptable para la provisión de cuidados de enfermería



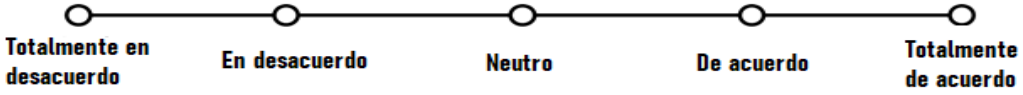
17. La teleenfermería es una forma adecuada de gestionar la mejora de la salud y las necesidades de los pacientes.



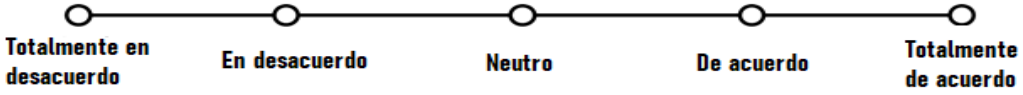
18. Tengo la intención de utilizar la tecnología de la teleenfermería en la atención y gestión de los pacientes en cuanto esté disponible en mi unidad de enfermería.



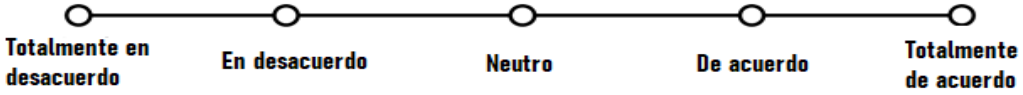
19. Los sistemas de teleenfermería me resultan irritantes.



20. El uso de las tecnologías de teleenfermería es apropiado para la prestación y gestión de los cuidados de enfermería.



21. La teleenfermería me permitirá aumentar la eficacia de mis servicios de atención al paciente.



22. En un desarrollo profesional de enfermería que abarque los aspectos integrales del cuidado de la salud (social, espiritual, psicológicos y físicos), ¿qué porcentaje de la actividad de cuidados cree que podría hacerse por teleenfermería? _____%

QUESTIONÁRIO

Instruções para o preenchimento do questionário

Este estudo é realizado pelas Universidades de Valência (UV e UPV, Espanha) e Porto (Portugal) com o objetivo de conhecer a opinião dos enfermeiros sobre a teleenfermagem. O responsável pelo estudo é o Dr. Júlio E.Marco-Franco (juemar@alumni.uv.es). Quaisquer perguntas que possa ter podem ser enviadas para este endereço de correio electrónico.

1. A sua participação no estudo é voluntária e não remunerada. Espera-se que os resultados do estudo sejam úteis para a comunidade de enfermagem.

2. A investigação centra-se nos enfermeiros da área clínica. Enfermeiros a exercerem funções de gestão, funções executivas, atividades governamentais ou públicas, investigação, ou ensino não devem preencher o questionário.

3. Caso não tenha experiência anterior em teleenfermagem, tente dar a sua opinião considerando a possibilidade de se juntar a uma equipa de teleenfermagem, com base nas suas experiências anteriores em atendimento e orientação sobre cuidados, a doentes, via telefone, utilização de meios digitais (smartphones, e-mail, redes sociais, consumo de música baseada na nuvem, etc.) e na sua perspetiva de comportamento.

4. Os resultados são completamente anónimos. Não há respostas certas ou erradas. Qualquer resposta é válida e apropriada. Por favor, responda a todas as perguntas. Por favor, assinale a resposta que mais se aproxima da sua opinião.

5. Se responder ao questionário em papel, assinale um único círculo com um x para indicar a resposta que acha que representa a sua opinião para cada questão. Lembre-se, por favor, assinale apenas uma resposta das cinco possibilidades:

6. Se se enganar, marque a resposta errada com um quadrado e remarque a correta como indicado.

7. Se responder online, o sistema permitir-lhe-á alterar a sua resposta. Não há necessidade de responder a todas as perguntas de uma só vez. Se necessário leve alguns dias para responder, mas, por favor, responda a todas as questões. Submeta o questionário quando estiver concluído.

8. Lembre-se de que o sistema não irá solicitar ou armazenar qualquer informação pessoal; se voltar a iniciar sessão a partir de um computador ou smartphone diferente, a informação anterior será perdida.

9. O estudo segue os princípios da Declaração de Helsínquia (Associação Médica Mundial 2013). Os dados são armazenados anonimamente, sem qualquer referência à identidade. Nenhuma informação recolhida neste questionário pode ser ligada a qualquer indivíduo. O estudo segue o procedimento estabelecido pelo Comité de Ética da Universidade de Valência para estes inquéritos.

10. Muito obrigado pela sua participação!

Dados demográficos gerais (anónimos)

Por favor, não inclua qualquer informação que o possa identificar.

A. Ano de nascimento (xxxx) (apenas ano)

☐☐☐☐

B. Género

Masculino..... ☐

Feminino..... ☐

Outro ..... ☐

C. Número de anos a trabalhar em enfermagem (XX)

☐☐

D. País. Por favor assinale X

Espanha..... ☐

Portugal..... ☐

Outro (indicar)_____ ☐

E. Local de trabalho (se estiver desempregado, indique a área onde trabalhou mais tempo). Assinale por favor X

Enfermagem primária e comunitária..... ☐

Enfermagem hospitalar..... ☐

Cuidados residenciais..... ☐

F. Nível académico (mais elevado). Se tiver várias qualificações, marque com X apenas a mais elevada

Curso de auxiliar/técnico de enfermagem..... ☐

Licenciatura/Curso em enfermagem..... ☐

Mestrado em enfermagem ou ciências da saúde..... ☐

Doutoramento em enfermagem ou ciências da saúde..... ☐

G. Especialidade em enfermagem ...SI.... ☐ NO.... ☐

H. Experiência na utilização de teleenfermagem (total ou parcial)

Nunca usei teleenfermagem..... ☐

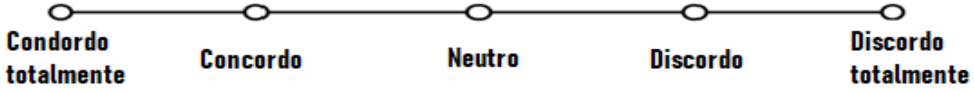
Dois anos ou menos ..... ☐

Mais de dois anos..... ☐

Questionário

1. Em geral, considero a teleenfermagem: ..... útil ☐ inútil ☐

2. Acho que estaria disposto(a) a usar um sistema de teleenfermagem.

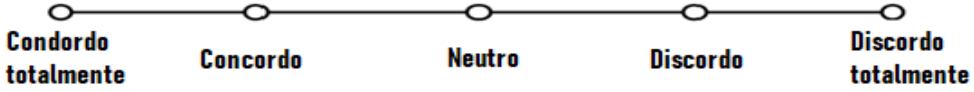


3. Limitar-me-ei a utilizar a teleenfermagem apenas para as tarefas de enfermagem mais básicas.

4. Não tenho qualquer problema se a organização me exigir a utilização de teleenfermagem

5. Na medida do possível, utilizarei a teleenfermagem para realizar diferentes tarefas, clínicas e não-clínicas.

6. A prestação e gestão adequada de cuidados ao doente não pode ser devidamente prestada através de teleenfermagem.



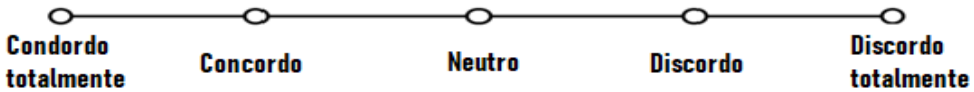
7. Em geral, considero a teleenfermagem..... aceitável ☐ inaceitável ☐

8. Não utilizarei a teleenfermagem a menos que seja obrigatório no meu serviço/instituição.

9. Para o trabalho de enfermagem, os sistemas de teleenfermagem são inapropriados ☐ apropriados ☐

10. É difícil gerir a saúde e as necessidades dos doentes com teleenfermagem.

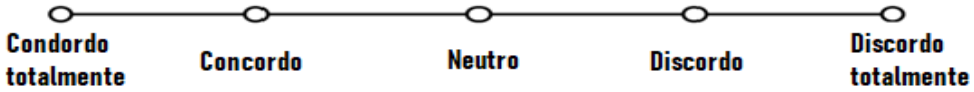
11. Não vejo a importância da teleenfermagem para os cuidados de enfermagem.



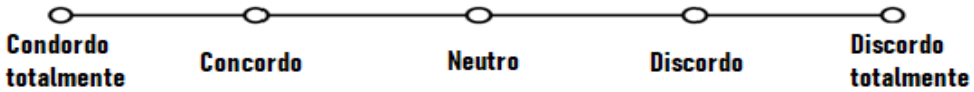
12. A utilização da teleenfermagem nos cuidados ao doente é satisfatória.

13. A teleenfermagem irá atrasar a minha capacidade de prestar cuidados ao doente.

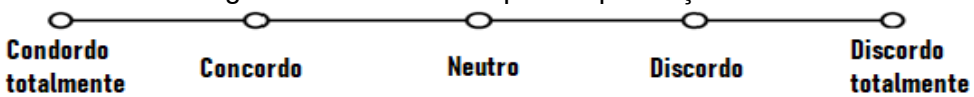
14. Tentarei adiar a utilização da teleenfermagem o máximo de tempo possível.



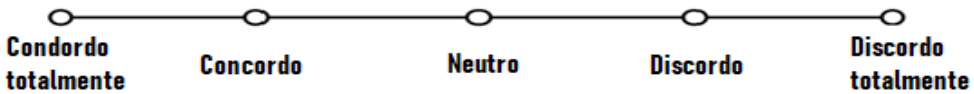
15. Considero que os sistemas de teleenfermagem são importantes para os cuidados de enfermagem.



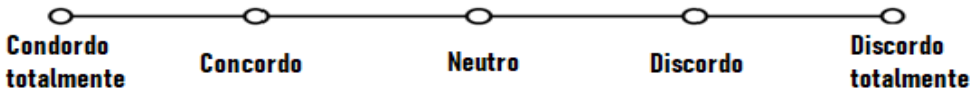
16. A teleenfermagem não é aceitável para a prestação de cuidados de enfermagem.



17. A teleenfermagem é uma forma adequada de gerir a melhoria da saúde e das necessidades dos doentes.



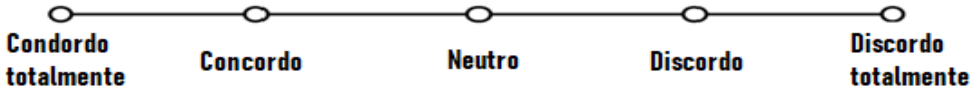
18. Pretendo utilizar a tecnologia de teleenfermagem nos cuidados e gestão de doentes assim que ela esteja disponível na minha unidade.



19. Acho os sistemas de teleenfermagem irritantes.

20. A utilização de tecnologias de teleenfermagem é apropriada para a prestação e gestão de cuidados de enfermagem.

21. A teleenfermagem permitir-me-á aumentar a eficiência dos meus cuidados ao doente.



22. Num desenvolvimento profissional de enfermagem que englobe os aspetos holísticos dos cuidados de saúde (sociais, espirituais, psicológicos e físicos), que percentagem da atividade de cuidar pensa que poderia ser feita por tele-enfermagem? _____%

KWESTIONARIUSZ

Instrukcja wypełniania kwestionariusza wielokrotnego wyboru

Niniejsze badanie opracowane zostało przez uniwersytety z Walencji (UV i UPV, Hiszpania) i z Oporto (Portugalia) w celu uzyskania informacji o telepielęgniarstwie z punktu widzenia pracowników pielęgniarstwa. Osobą odpowiedzialną za badanie jest dr med. Julio E. Marco-Franco (juemar@alumni.uv.es). Wszelkie wątpliwości można kierować pod podany wyżej adres poczty elektronicznej.

1. Kwestionariusz jest dobrowolny i nieodpłatny a jego wyniki mają posłużyć społeczności pielęgniarskiej.

2. Badanie skupia się wyłącznie na pracownikach pielęgniarstwa/asystentach w obrębie praktyki klinicznej. Pracownicy pielęgniarstwa zajmujący się zarządzaniem, funkcjami wykonawczymi, czynnościami rządowymi czy publicznymi, badaniami czy nauczaniem nie powinni go wypełniać.

3. Jeśli nie masz doświadczenia w telepielęgniarstwie odpowiedz próbując przewidzieć jak byś się zachował w przypadku rozpoczęcia pracy w zespole z tego typu systemem, opierając się na doświadczeniu w kontakcie telefonicznym z pacjentami i korzystaniu z cyfrowych środków przekazu (smartfonów, poczty elektronicznej, portali społecznościowych, muzyki w chmurze, itd.).

4. Wyniki badania są całkowicie anonimowe. Nie ma dobrych ani złych odpowiedzi. Prosimy o odpowiedź na wszystkie pytania. Każda odpowiedź jest ważna i dobra. Zaznacz tę, która najlepiej odzwierciedla twoją opinię.

5. Jeśli wypełniasz kwestionariusz w wersji papierowej, wskaż odpowiedź, która najlepiej odzwierciedla twoją opinię w danej kwestii stawiając „x” w jednym z kółek. Pamiętaj, aby zaznaczyć tylko jedną z pięciu możliwych odpowiedzi:

6. Jeśli się pomylisz, otocz błędną odpowiedź kwadratem i zaznacz ponownie poprawną odpowiedź, jak w przykładzie poniżej.

Właściwa Niewłaściwa

7. Jeśli wypełniasz kwestionariusz on-line, system pozwoli ci zmienić odpowiedź. Nie trzeba odpowiadać na wszystkie pytania od razu. Jeśli to konieczne przeznacz kilka dni na wypełnienie kwestionariusza, ale postaraj się odpowiedzieć na wszystkie pytania. Prześlij kwestionariusz kiedy będzie gotowy.

8. Pamiętaj o tym, że system nie zapyta cię o żadne dane osobowe ani nie będzie ich przechowywał; jeśli podłączysz się ponownie z innego smartfonu lub komputera, stracisz wcześniej podane informacje.

9. Badanie przeprowadzane jest zgodnie z zasadami Deklaracji Helsińskiej (Światowe Stowarzyszenie Medyczne 2013). Dane przechowywane są anonimowo beż żadnych oznaczeń identyfikacyjnych. Nie ma możliwości przypisania zebranych informacji żadnej konkretnej osobie. Badanie jest zgodne z procedurą ustaloną przez Komitet Etyki Uniwersytetu w Walencji dla tego typu ankiet.

10. Dziękujemy za udział w badaniu!

Ogólne dane demograficzne (anonimowe).

Nie załączaj żadnej informacji, która mogłaby posłużyć twojej identyfikacji.

A. Rok urodzenia (xxxx) (tylko rok)

☐☐☐☐

B. Płeć

męska.....	☐
żeńska.....	☐
inna	☐

C. Lata przepracowane w pielęgniarstwie (XX) (w przypadku wcześniejszej pracy w charakterze asystenta, wskaż pełny staż pracy w zawodzie).....

☐☐

D. Kraj. Postaw „X".

Hiszpania.....	☐
Portugalia.....	☐
Polska	☐

E. Miejsce pracy (w przypadku bycia bezrobotnym, wskaż obszar najdłuższego stażu pracy). Postaw „X".

Pielęgniarstwo podstawowe i środowiskowe.....	☐
Pielęgniarstwo szpitalne.....	☐
Domy opieki.....	☐

F. Wykształcenie (najwyższe). Jeśli posiadasz więcej niż jeden tytuł, postaw „X" tylko przy najwyższym z nich.

Certyfikat Asystenta Pielęgniarstwa/Opiekuna Medycznego.....	☐
Studia pielęgniarskie pierwszego stopnia (3 lata)	☐
Studia pielęgniarskie drugiego stopnia (2 lata)...	☐
Studia podyplomowe w dziedzinie pielęgniarstwa lub nauk o zdrowiu …….....	☐
Doktorat w dziedzinie pielęgniarstwa lub nauk o zdrowiu …….....	☐

G. Doświadczenie w pracy z telepielęgniarstwem (pełnej lub częściowej)

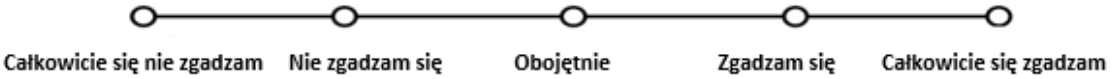
Całkowity brak doświadczenia	☐
Dwa lata lub mniej	☐
Ponad dwa lata	☐

Pytania

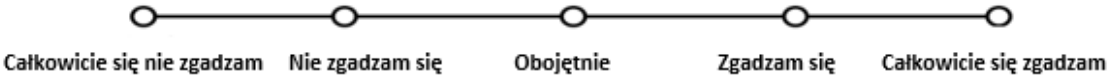
1. Ogólnie uważam telepielęgniarstwo za.....

przydatne ☐
bezużyteczne ☐

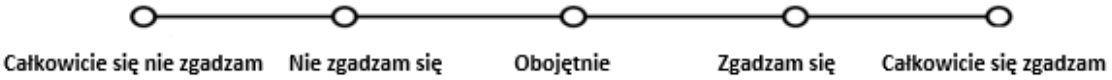
2. Myślę, że będę chcieć korzystać z systemu telepielęgniarstwa.



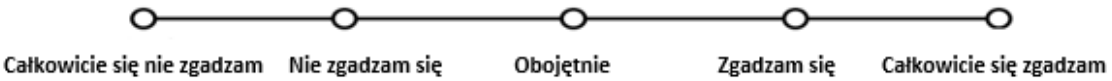
3. Ograniczę się do korzystania z telepielęgniarstwa tylko do najbardziej podstawowych czynności z zakresu pielęgniarstwa.



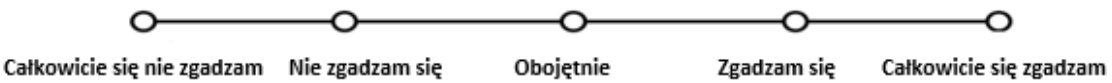
4. Nie widzę problemu w korzystaniu z telepielęgniarstwa, jeśli organizacja będzie tego ode mnie wymagać.



5. Na ile to możliwe będę korzystać z telepielęgniarstwa do wykonywania różnych zadań zarówno klinicznych, jak i nieklinicznych.



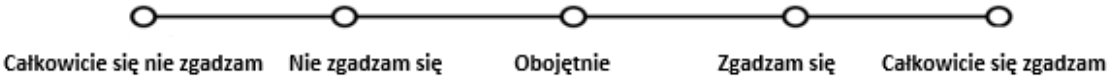
6. Nie można zapewnić odpowiedniej opieki i postępowania z pacjentem za pośrednictwem telepielęgniarstwa.



7. Ogólnie uważam telepielęgniarstwo za

możliwe do zaakceptowania ☐
niemożliwe do zaakceptowania ☐

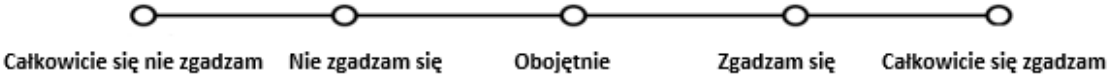
8. Nie będę korzystać z telepielęgniarstwa w pracy jeśli nie będzie to obowiązkowe.



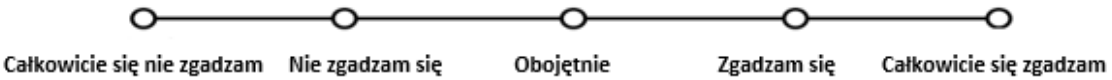
9. Do pracy w zakresie pielęgniarstwa systemy telepielęgniarstwa są

nieodpowiednie ☐
odpowiednie ☐

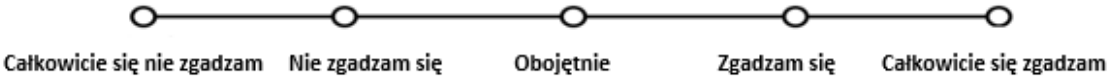
10. Trudno jest zarządzać zdrowiem i potrzebami pacjentów przy pomocy telepielęgniarstwa.



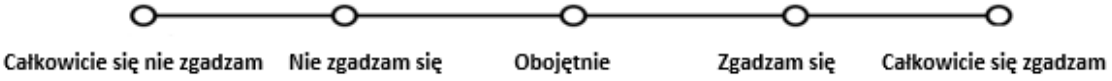
11. Nie uważam aby telepielęgniarstwo w opiece pielęgniarskiej było istotne.



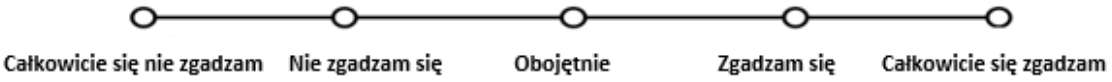
12. Korzystanie z telepielęgniarstwa w opiece nad pacjentem jest satysfakcjonujące.



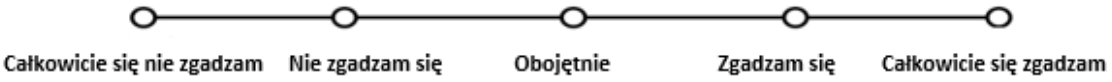
13. Telepielęgniarstwo jest opóźnione w stosunku do moich umiejętności w zakresie opieki nad pacjentem.



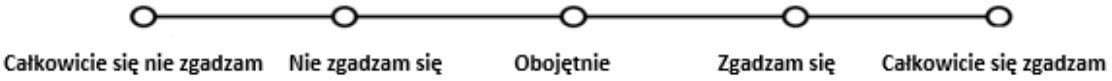
14. Spróbuję odłożyć w czasie korzystanie z telepielęgniarstwa tak długo jak tylko będzie to możliwe.



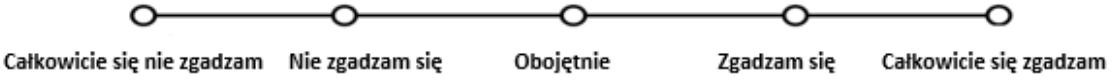
15. Uważam, że systemy telepielęgniarstwa są istotne w opiece z zakresu pielęgniarstwa.



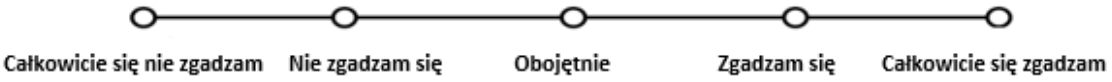
16. Telepielęgniarstwo jest nie do zaakceptowania w świadczeniu opieki pielęgniarskiej.



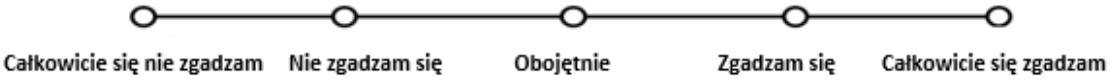
17. Telepielęgniarstwo jest odpowiednią formą zarządzania poprawą zdrowia i potrzebami pacjentów.



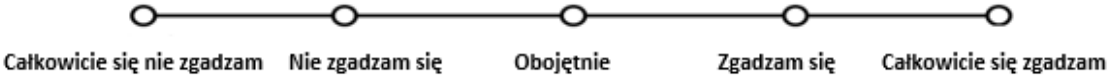
18. Zamierzam korzystać z technologii telepielęgniarstwa do zarządzania i opieki nad pacjentami kiedy tylko będzie ona dostępna w moim oddziale pielęgniarskim.



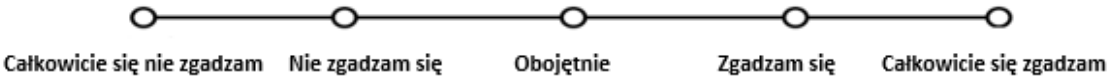
19. Uważam systemy telepielęgniarstwa za irytujące.



20. Wykorzystanie technologii telepielęgniarstwa jest odpowiednie do świadczenia opieki i zarządzania w zakresie pielęgniarstwa.



21. Telepielęgniarstwo pozwoli mi zwiększyć wydajność moich usług w zakresie opieki nad pacjentem.



Jaki procent czynności w zakresie pielęgniarstwa twoim zdaniem można by przeprowadzać za pośrednictwem telepielęgniarstwa biorąc pod uwagę wszystkie aspekty opieki zdrowotnej (społeczne, duchowe, psychologiczne i fizyczne)?

10. ‖ APPENDIX II: PUBLICATIONS

mathematics

MDPI

Article

Validation of a New Telenursing Questionnaire: Testing the Test

Julio Emilio Marco-Franco [1,2], Margarida Reis-Santos [3], Isabel Barrachina-Martínez [2,*], Silvia González-de-Julián [2] and Ramón Camaño-Puig [1]

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Abstract: Background: Existing surveys on telenursing refer to specific areas of nursing after the implementation of a programme, but telenursing in general has not been fully evaluated from a prospective approach. Aim: Design and statistical validation of a telenursing questionnaire. Methods: A new questionnaire was designed with 18 paired (to avoid leading) questions (Likert-5) plus three dichotomous questions (randomly ordered, inspired by existing validated tests) to analyse the dimensions of: acceptance, usefulness and appropriateness of telenursing from the nursing point of view (7 min test). The questionnaire was validated by classical tests and item response tests (Rasch) using six computer-generated databases with different response profiles (tendency to be positioned against, neutral and positioned in favour) with two degrees of agreement between each pair of responses for each option. Results: Classical testing: Cronbach's alphas (from 0.8 to 0.95), Kaiser–Meyer–Olkin (KMO) (0.93 to 0.95) and a significant $p < 0.0001$ for Bartlett's test of sphericity were obtained. Rasch analysis: Reliability coefficients (0.94). Warm's mean weighted likelihood estimates (0.94). Extreme infit-t and outfit-t values (+1.61 to −1.98). Conclusions: Both the classical test and the Rasch approaches confirm the usefulness of the new test for assessing nurses' positioning in relation to telenursing.

Keywords: telenursing; assessment instrument; Rasch model; joint maximum likelihood estimation; questionnaire; survey; e-nursing; digital nursing

MSC: 94A50; theory of questionnaires; 62P10 applications of statistics to biology and medical sciences

Citation: Marco-Franco, J.E.; Reis-Santos, M.; Barrachina-Martínez, I.; González-de-Julián, S.; Camaño-Puig, R. Validation of a New Telenursing Questionnaire: Testing the Test. *Mathematics* **2022**, *10*, 2463. https://doi.org/10.3390/math10142463

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1. Introduction

Internet of Things (IoT) technology is a growing innovation in everyday life [1], but in nursing healthcare, it is still in an emerging and early developmental phase [2]. Overall, the development of information and communication technologies (ICT) in nursing science—and in particular in telenursing—is an urgent need, the prominent reasons for which include the shortage of nursing staff, which is expected to be half (13 million) of the current estimated global workforce within a decade [3].

Telenursing can make a significant contribution to increasing retention of qualified nurses who, for various reasons, are unable to undertake full face-to-face activity, but who would be willing to work during certain agreed periods and hours on a flexible basis, especially in the case of pregnant or aged nurses [4–6].

Telenursing enables improved access to rural or remote areas, savings in travel time, cost containment and better standardisation through the electronic nursing summary and allows the incorporation of aids through digitised decision trees that allow better personalisation of care, better monitoring and subsequent quality analysis [7,8]. Remote

technology makes it possible to increase the possibilities of care for the general population to systematise health education recommendations and the early detection of situations requiring urgent care or advice on self-care [8–10].

Increasing computer processing capabilities and the ability of machines to learn from data (artificial intelligence) allow a continuous effort to find increasingly better solutions to complex problems both in basic research and in management [11–14].

Proper planning requires input from staff, and the case of telenursing is no exception [15]. It is necessary to provide a general and prospective overview in contrast to published works that focus on partial aspects (telephonic care) or on specific nursing specialities [8,16]. However, to date and to the best of our knowledge, there has not been a comprehensive assessment in prospective terms, i.e., nurses who are not yet working in telenursing, nor is there a validated questionnaire in this regard. The extension of the survey to both current and future users of telenursing with a focus on proper remote holistic nursing care delivery, leaving aside the use of ICT in teaching or nursing management, is a novel approach that will hopefully allow for better future planning.

The design and validation of a specific questionnaire for telenursing is presented here as a new instrument for future practical use. The variants considered cover all response possibilities in a real situation and even meaningless random responses to question pairs can be detected by summation of differences between pairs.

2. Materials and Methods

The progress of the questionnaire design was carried out in five phases: (1) review of the literature; (2) construct; (3) development of domains; (4) development of items (questions); (5) testing and validation [17,18].

The questions were inspired by the most commonly used questionnaires in the literature for this purpose: the System Usability Scale (SUS) [19], the Technology Acceptance Models (TAM, TAM3) [20,21] and the Telenursing Interaction and Satisfaction Questionnaire (TISQ) [22]. Each of the five authors selected questions independently, and these were reformulated according to the complexity of the text and the Flesh–Kincaid level of comprehension for text complexity [23,24].

The final number of items was selected as a compromise between including paired questions to prevent leading questions and including at least three paired questions for each dimension [25–27]. A final selection for these 18 questions was made by each author scoring the best questions from the set of 49 pre-selected questions and with three rounds of scoring the questions until complete agreement was achieved.

The domains tested included:

- Perceived usefulness
- Prospective acceptance
- Appropriateness for nursing tasks

Each domain also included a global yes/no question.

The length of the questionnaire—and consequently, the estimated time to complete it—was carefully selected following the recommended principle of "the shorter the better" [28–30]. It is recommended that there be no fewer than three questions for each item [31], representing six questions (three pairs) per dimension and a total of 18 polytomous questions. In addition, there is one dichotomous question for each dimension, resulting in 21 questions to be completed in an estimated time of 7 min.

The structured questionnaire (Supplementary Materials) included three dichotomous questions and 18 polytomous questions with answers on a 5-point Likert scale.

To reproduce all possible variety of responses, covering all real possible answers in the different scenarios (in favour, against, consistency, inconsistency), six different databases were generated by a computer, with 120 fictitious respondents in each case. Each database corresponds to a different profile. These were designed with three levels of skewness, representing a majority (2/3) of answers against telenursing, an equal number of answers in favour and against and a third option with a majority in favour of telenursing (2/3).

The design included in each case two variants: good-paired responses (pairwise difference range [−1 to +1]) and poor-paired responses (pairwise difference [−2 to +2]) (Table 1). The dichotomous variables were generated with the formula:

$$\text{IF(SUM}(x{:}y) \geq 5;1;0) \quad (1)$$

where $x{:}y$ represents the sum of the Likert values for each dimension.

Table 1. Codes and characteristics of databases.

Database Code	Symmetry	Pairwise Difference
Fic R + NO	Positive	Poor
Fic R + Rel	Positive	Good
Fic Syim NO	Central	Poor
Fic Sym Rel	Central	Good
Fic L—NO	Negative	Poor
Fic L—Rel	Negative	Good

Leading questions were ruled out by using paired (one positive and one negative) randomly disordered questions. Statistical processing requires reversing the score of the negative answers and reordering them, as all questions must grow in the same direction (Table 2).

Table 2. Required reordering of questions before running the statistics.

	Polytomous		
	Usefulness	**Acceptance**	**Appropriateness**
	−18	4	17
	−8	−14	−10
	5	2	15
	−3	−19	−11
	21	12	20
	−13	−16	−6
Dichotomous	1	7	9

Note: Questions with a negative sign should be score-reversed (1 = 5, etc.).

Calculations were performed with IBM-SPSS statistics package V26 for Classical Test Theory (CTT).

Regarding the item response theory (IRT), a Rasch analysis was performed with R (basic packages: MASS, eRm, sirt, TAM), obtaining the inlier-sensitive or information-weighted fit (infit-t), i.e., standardized as a z-score, standardized outlier-sensitive fit (outfit-t), betas, level of difficulty, level of discrimination, reliability ratio, Warm's mean weighted likelihood estimates (WLE), item characteristic curves (ICC) and item information curves (IIC).

Internal consistency of the three dimensions can be analysed using Cronbach's alpha

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\Sigma\alpha_k^2}{\alpha_{Total}^2}\right], \quad (2)$$

where k is the number of items, $\Sigma\alpha_k^2$ is the variance of the item and α_{Total}^2 is the total variance.

3. Results

3.1. Descriptive Statistic Results

The basic results in terms of Likert answers are presented in Figure 1.

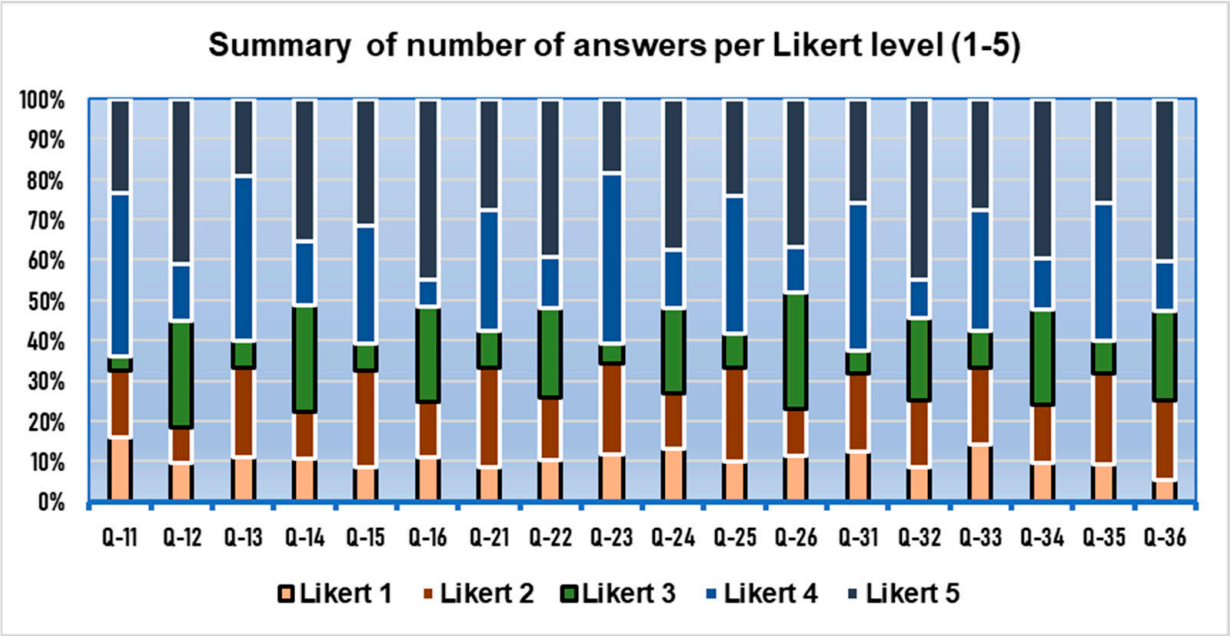

Figure 1. Polytomous responses for a database with negative asymmetry and well-paired data (Fic L—Rel).

As for dichotomous responses, for the same database, Figure 2 shows an acceptability between 68.3% in usefulness and 73.3% in appropriateness.

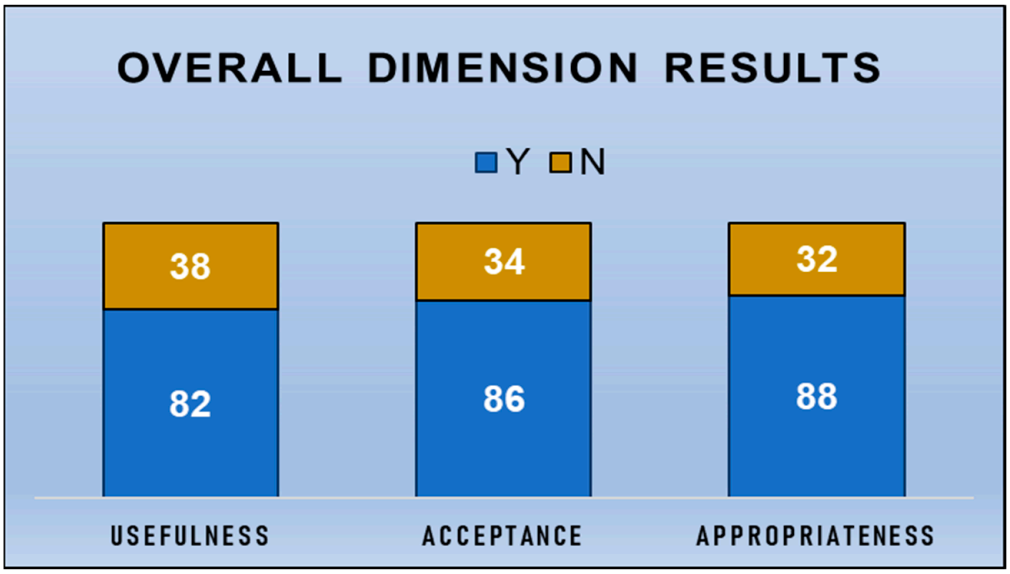

Figure 2. Dichotomous responses by dimensions. Same database (Fic L—Rel).

A general statistical descriptive summary allows the intentionally different skewedness of the databases and other basic information to be seen (Table 3).

Table 3. Descriptive statistics of the databases.

Database	Fic R + NO		Fic R + Rel		Fic Sym NO		Fic Sym Rel		Fic L—NO		Fic L—Rel	
Data ($\bar{Y}$)	Categorial	Ordinal	Categorial	Ordinal	Categorial	Ordinal	Categorial	Ordinal	Categorial	Ordinal	Categorial	Ordinal
Mean		0.55		0.47		0.67		0.62		0.74		0.73
Standard error		0.05		0.05		0.04		0.04		0.04		0.04
Median of medians		2.8		2.0		3.0		3.0		4.0		4.0
Standard deviation		0.50		0.50		0.47		0.49		0.44		0.44
Variance		0.25		0.25		0.22		0.24		0.20		0.20
Kurtosis		−1.99		−2.02		−1.51		−1.78		−0.83		−0.86
Skewness		−0.20		0.12		−0.72		−0.50		−1.09		−1.07
Mean of sums		66.00		56.33		85.00		74.33		88.33		88.00
Subject count		120		120		120		120		120		120
Positive responses (%)	55.0		46.9		66.7		61.9		73.6		73.3	

Note that polytomous ordinal variables (1 to 5) are treated as numerical. Results are only for comparative purposes, but no statistics may be computed due to this restriction [32].

3.2. CTT Statistics Results

Cronbach's alpha uses the covariances between the items, whereas the standardised item format is based on the correlations between the items; in this case, this is already assumed as present. Therefore, the approach here is not to assume that the items have equal variances, as in practice, this is not often the case. Table 4 summarises the non-standardised Cronbach's alpha of the polytomous variables for each database (based on covariances analyses) for each dimension. The 95% confidence intervals (CI) for Cronbach's alpha have been computed using the interclass correlation coefficients which result identical to Cronbach's alpha (when calculated with the two-way mixed consistency or two-way random consistency models). Hence, this is a CI for alpha as well (Table 4).

Table 4. Descriptive statistics of polytomous items. Cronbach's alpha.

Database	Fic R + NO			Fic R + Rel			Fic Sym NO			Fic Sym Rel			Fic L—NO			Fic L—Rel		
Domains	**Us**	**Acc**	**App**	**Us**	**Acc**	**App**	**Us**	**Acc**	**App**	**Us**	**Acc**	**App**	**Us**	**Acc**	**App**	**Us**	**Acc**	**App**
Cronbach α	0.84	0.86	0.84	0.94	0.95	0.94	0.83	0.80	0.82	0.94	0.95	0.94	0.82	0.83	0.84	0.94	0.95	0.95
Cronbach α		0.94			0.98			0.93			0.98			0.94			0.98	
95% CI		0.93–0.96			0.91–0.98			0.91–0.95			0.97–0.98			0.92–0.95			0.97–0.98	
					(Covariances)													

Note: Us = Usefulness. Acc = Acceptance. App = Appropriateness.

The principal component analysis was run to evaluate the strength of the partial correlation, or how the factors (items) explain each other and to test the adequacy of factor analysis. Kaiser–Meyer–Olkin (KMO) values indicate the sampling adequacy for factor analysis and Bartlett's test of sphericity (method of covariances and varimax rotation) returned highly significant *p*-values (0.000), implying that the correlation matrix is indeed not an identity matrix (rejection of the null hypothesis) (Table 5).

Table 5. Principal components analyses.

Database	Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel
KMO	0.93	0.95	0.94	0.93	0.93	0.94
Bartlett	0.000	0.000	0.000	0.000	0.000	0.000

3.3. IRT-Rasch Results

The Rasch model was proposed by the Danish mathematician Georg Rasch after research between 1951 and 1959 and was first used to measure the intelligence of Danish soldiers, being subsequently widely used in psychometric assessments [33]. It was created for the analysis of dichotomous data, although later developments extended to polytomous data, either ordinal [34] or continuous [35]. The model analyses the responses of n individuals to i items and the probability of a positive outcome (favourable, or correct answer) $(X_{ni} = x = 1)$ $x \in \{0, 1\}$ (dichotomous in the original paper). It is given by the logistic function:

$$P(X_{ni} = 1|\beta_n, \delta_i) = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}} \quad (3)$$

where β_n represents the first factor (individual factor) and δ_i the second factor (item factor).

It is possible to set a general rule of two factors—the former for personal ability and the second for item difficulty, expressed as log odds units (logits). It is a probabilistic latent structure model with remarkably increasing use for the evaluation of scales.

Rasch testing for dichotomous logistic data is the standard for exponential family models and is mainly based on conditional maximum likelihood. This provides the possibility of different approaches to likelihood estimation (LE). The Warm's mean weighted likelihood estimates (WLE) of Rasch measures has been used, but a review of 215 studies and 23 software packages showed no significant differences between different LE approaches [36]. Expected a posteriori (EAP) person parameters were also included.

The results showed that the Rasch test of the EAP reliability score of 0.70 for the dichotomous data is not as good as the 0.94 for the Likert-5 polytomous data. However, the infit-t and outfit-t of the dichotomous variables are very centred, and the coefficients of reality of the polytomous variables, using Warm's mean weighted likelihood estimates, are always >0.9 (Table 6). This suggests that a dichotomous-only questionnaire would not be as appropriate as a mixed model including polytomous Likert-scale data.

Table 6. Rasch analysis.

Database		Fic R + NO	Fic R + Rel	Fic Sym NO	Fic Sym Rel	Fic L—NO	Fic L—Rel	Averages
Dichotomous	EAP Real	0.74	0.75	0.67	0.72	0.64	0.66	0.70
	D1-Infit-t	0.35	−0.98	0.45	0.21	0.47	−1.10	−0.10
	D2-Infit-t	0.35	0.23	−0.43	−0.66	−1.61	2.03	−0.01
	D3-Infit-t	−1.04	0.34	0.05	0.52	0.91	−0.57	0.04
	D1-Outfit-t	0.33	−1.01	0.44	0.20	0.45	1.24	−0.14
	D2-Outfit-t	0.33	0.23	−0.44	−0.67	−1.61	1.98	−0.03
	D3-Outfit-t	−1.14	0.32	0.05	0.53	0.89	−0.60	0.01
	Beta-D1 (0.95 CI)	−0.17	−0.37	−0.11	0.14	0.28	0.99	0.13
	Beta-D2 (0.95 CI)	−0.17	−0.12	0.11	−0.07	−0.06	−0.81	−0.19
	Beta-D3 (0.95 CI)	0.34	0.48	0.00	−0.07	−0.22	−0.19	0.06
	D1-Dffclt	0.03	−0.03	−0.47	−0.13	−0.71	−0.10	−0.24
	D1-Dscrmn	37.058	17.332	4.559	13.038	12.757	37.206	20.325
	D1-P ($x = 1 \mid z = 0$)	0.265	0.748	0.894	0.852	1.000	0.974	0.789
	D2-Dffclt	0.028	-0.076	−0.517	−0.118	−0.683	−0.051	−0.236
	D2-Dscrmn	37.058	17.332	4.559	13.038	12.757	37.206	20.325
	D2-P ($x = 1 \mid z = 0$)	0.265	0.789	0.913	0.823	1.000	0.870	0.777
	D3-Dffclt	0.014	−0.063	−0.492	−0.118	−0.670	−0.066	−0.233
	D3-Dscrmn	37.058	17.332	4.559	13.038	12.757	37.206	20.325
	D3-P ($x = 1 \mid z = 0$)	0.38	0.8683	0.90	0.82	0.9998	0.922	0.816
Polytomous	EAP reliab.	0.93	0.97	0.92	0.97	0.92	0.96	0.94
	WLE reliab.	0.92	0.96	0.91	0.97	0.92	0.96	0.94

Note: Warm's Mean Weighted Likelihood Estimates.

The item characteristic curves (ICC) and item information curves (IIC) are shown below (Figure 3).

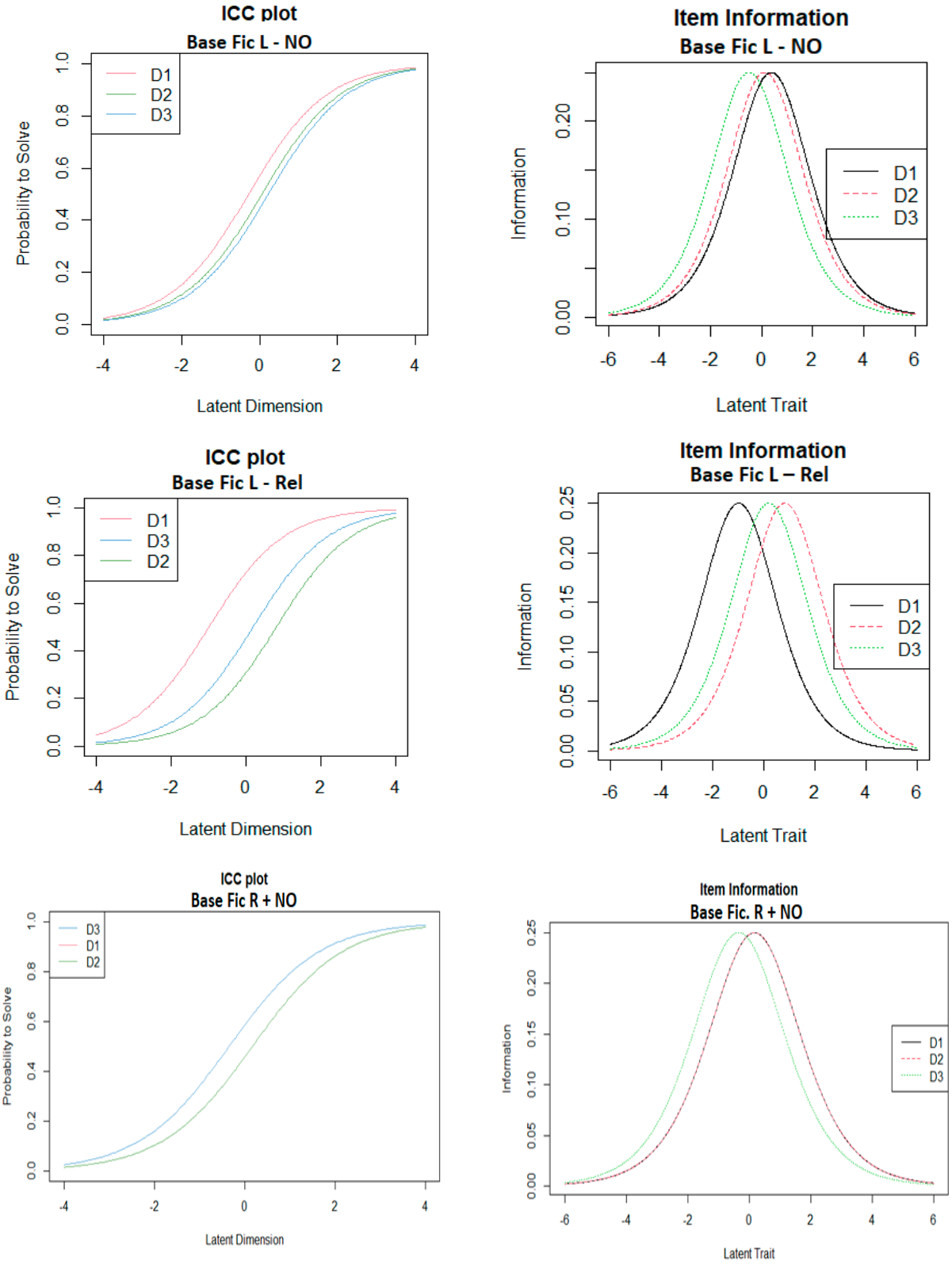

Figure 3. *Cont.*

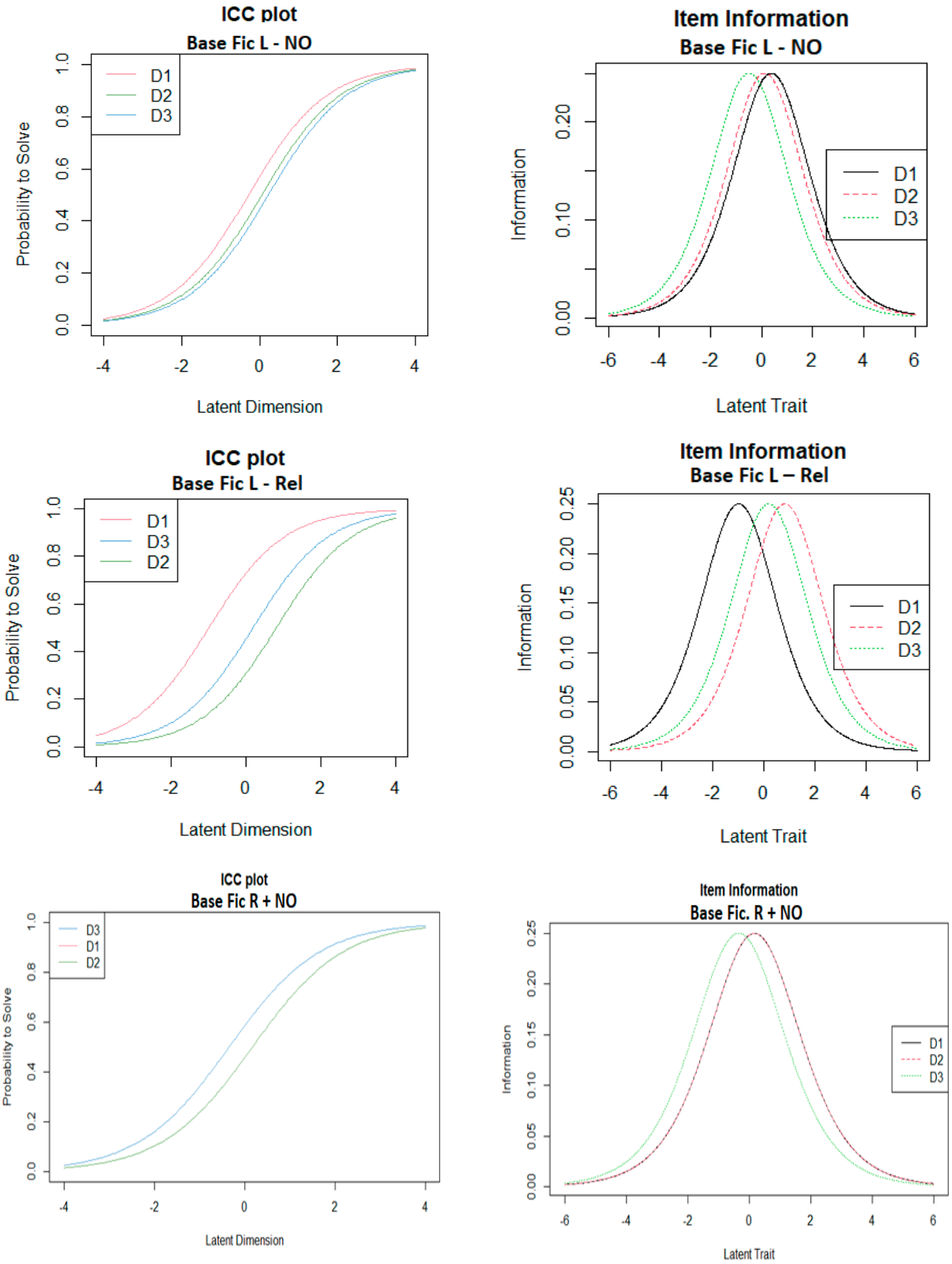

Figure 3. ICC and IIC charts for dichotomous variables (D1–D3).

4. Discussion

The results show that the questionnaire is robust for different possibilities of potential respondents and allows separate analysis of the three dimensions (usefulness, acceptability and appropriateness). Measurements, mainly based on questionnaires to assess a latent

trait, are well-established research procedures in the social sciences, extending to many other fields. The construct in our paper is designed to obtain the positioning of nurses in relation to telenursing.

The questions have been optimised in terms of time and items, with paired questions to prevent leading questions and including at least 3 + 3 questions for each dimension [25–27]. It is important to consider that the paired questions must be score-reversed before running statistics.

It would even be possible to include only one question with a dichotomous answer (yes: I am in favour of telenursing; no: I am not in favour of telenursing), but although the construct basically seeks that information, a wider approach is intended with a more ambitious scope of measuring three dimensions: perceived usefulness, prospective acceptance and appropriateness for nursing tasks. The EAP Rasch results for categorical variables show a lower score (0.70) when compared with polytomous questions (0.94). The significant overall test validation data obtained can be explained by the combination of categorical and polytomous variables. Latent variable mixture models are a promising approach for the validation of outcomes [37].

The design conditions some statistic results. The three dimensions are strongly related, and consequently, a significant number of collinearities are expected. The constatation of collinearities are here an expression of the interconnection of the dimensions in the construct, and obviously, it only reflects a specifically designed questionnaire. It is unsurprising to find redundancy patterns corresponding to a sedimentation graphic sharply descending after the second or third variable; total variance was over 70% explained with only two or three questions (components). It must be noted that not all indices of reliability can be used in all situations, and even Cronbach alpha, for example, cannot be used in all circumstances [38]. This test measures internal consistency and is most useful when used in a survey with single-dimensional data; otherwise, it risks underestimating the true result. It is therefore convenient to use the methodology for each group of items (dimensions) that make up the construct. This does not mean that the consistencies of each of the three dimensions cannot be assessed and compared with each other between databases, but correlation of dimensions must be considered as a limitation for the applicability of some statistics.

Although Cronbach alpha is not applicable to dichotomous variables, and while the use of a Kuder–Richardson analysis could additionally be considered for the dichotomous data, given these dichotomous variables were obtained from the polytomous variables using a mathematical formula [1], the computation has been considered unnecessary.

Reliability depends on the sample used for the test, and this may be affected by other considerations. Both performance variability and group performance level may affect score reliability [25]. Let us imagine that all the nurses on the planet were totally convinced of the advantages of telenursing and validated it as positive. Different samples obtained by surveys using a Likert scale will provide consistent results of 5 = totally agree. In this extreme case, it will provide a variance of 0. Different samples will offer the same results (high reliability and high validity), although variance is 0. If this pattern is followed in the second question as well (i.e., virtually every answer close to 5), this could lead to a determinant of the matrix (Φ) close to 0 due to the strong correlation of the variables.

A low score in the Kaiser–Meyer–Olkin test will express a high value of the correlation coefficients—and, consequently, the inappropriateness of the factor analysis—but at the same time, for diagonality testing and due to this high correlation, the null hypothesis that the correlation matrix is the identity matrix (Bartlett's test of sphericity) will be clearly rejected, as the comparison of the observed correlation matrix with the identity matrix will show a highly significant p. In conclusion, a larger variance of the total scores does not mean a higher reliability in all cases.

This emphasises the question that the statistical approach must focus on the particular data obtained and not on a blind application of mathematical tests and that not all indexes of reliability can be used in all situations [38]. It also reveals the weakness of the CTT that

focuses on the test as a whole and the need to include a separate analysis of items with other latent structure models and/or probabilistic models.

An additive Likert scale was considered a popular option for this questionnaire compared to Thurstone or Guttman scales. However, two considerations are pertinent. Although often analysed as numerical, Likert scales are ordinal, and it is possible that in future surveys, data may be (left) negatively skewed (majority of favourable answers) with a significant number of values 4 or 5 considering the foreseeable tendency to consider telenursing as professionally positive. To what extent these two factors break the constraints of the analysis of variance (ANOVA) requiring continuous values with a Gaussian curve must be analysed in each case. In extreme cases, a non-parametric test could be used (Spearman tests of ranks). To evaluate the robustness of the questionnaire, databases with different types of skewness have been tested.

Note that there may be other reasons why factor analysis may not be appropriate. The main purpose of this multivariate statistical technique is to synthesise the observed interactions between a set of variables in a concise way and to explore the unobservable latent (hidden) variable presumed within the logic of the framework of the theory. However, in this case, the three dimensions are provided a priori. This could become an exploratory analysis; if the KMO were higher than 0.71—and therefore factor analysis could be considered appropriate—a collinearity would still to be expected, a rotation (in principle orthogonal, e.g., varimax rotation, with Kaiser normalisation) should be used and small coefficients (<0.5) should be deleted.

It is not advisable to analyse Cronbach's alpha for the whole questionnaire or for the questions independently, as with a number of questions higher than 20, acceptable alpha values could result even though they may consist of two or three orthogonal dimensions; very high values (over 0.90) may also express the (expected) redundancy among items. Cronbach's alpha is not to be used as the sole source of validity evidence [27]. Running Cronbach's alpha for each dimension seems a rational in-between approach.

CTT has also been criticised for requiring imputation methodology for missing data, imprecision of standard errors and distortion (as commented above) of extreme cases and ordinal data handled through intervals [39]. As per Andrich, modern test theory—which includes IRT and its variant, Rasch measurement theory—will increasingly replace classical test theory in the analysis of rating scales and in the presentation of outcome measures [34].

IRT methodologies are widely used in educational contexts, psychological tests and questionnaires. The main characteristic of all IRT models is that the assessment of the latent trait is considered to be conditional on the respondent and the questionnaire items, and therefore IRT models are based on statistics obtained by estimating the respondent characteristics and item characteristics [40].

In real testing, the dichotomous (D1–D3) data will not be automatically generated by the computer, but it would be interesting to compare the results with those generated with the formula indicated above [1] (e.g., with the Kendall rank correlation coefficient test) to see the concordance between polytomous and dichotomous data.

The SPSS software does not include Rasch analysis in the current (26) version. However, conditional maximum likelihood estimation Rasch analysis (for dummy variables) has been reported with a log-linear subroutine [41], and there is also an R Integration Package for IBM SPSS Statistics. The most popular software for Rasch analysis includes Winsteps (paid) and R (free).

The major advantage of the Rasch model over the CTT is the property of joint measurement of item and subject parameters in the same construct. Another advantage is that the Rasch model assumes unidimensionality, i.e., that all responses are conditioned by a single latent variable, which in this case is the consideration of telenursing.

The computerised analysis customarily calculates the differences between observed and expected responses (i.e., expressing the residuals). For the respondent r and the item q (where $r, n \wedge q \in i$), the residual y_{rq} is computed as:

$$y_{rq} = x_{rq} - P_{rq} \quad (4)$$

where x_{rq} is the observed response to the question and P_{rq} the probability of a favourable answer to the question.

Usually, the residuals are standardised (z_{rq}) by dividing the residual by the standard deviation (SD); thus:

$$z_{rq} = \frac{y_{rq}}{\sqrt{P_{rq}(1 - P_{rq})}} \tag{5}$$

This allows computation of the mean square (MNSQ) value of the (inlier-sensitive, weighted) Infit, which is the average of the quadratic residuals weighted with their weighted mean square (W), as a model fitting test.

$$\text{Infit (MNSQ)} = \frac{\sum_n^N W_{ni} z_{ni}^2}{\sum_n^N W_{ni}} \tag{6}$$

It is also possible to compute the Infit for one person or for one question. The Infit plays an essential role in Rasch testing. It expresses the global fit adjustment. The goodness of fit is a measure of symmetry (Gaussian curve) and has no rationale in computer-generated database testing, as the databases have been designed specifically for different skewness.

The Outfit is an outlier-sensitive fit statistic based on the conventional chi-square test:

$$\text{Outfit (MNSQ unweighted)} = u_i = \sum_{n=1}^{N} \frac{z_{ni}^2}{N} \tag{7}$$

MNSQ statistics represent the size of the randomness. Although a very conservative extent (0.7–1.3) could be considered, a range of values between 0.5 and 1.5 of MNSQ is usually accepted. Outliers represent distortion of the model. Values over 2 may indicate very few observations, and, contrariwise, values lower than 0.5 may suggest misleading reliability.

The infit-t (or Z) and outfit-t are typical standardised values for the degree of fit of the person or the item factor. Values will typically fall between -1.9 and + 1.9 for reasonable predictability of the model as they do in our case. Values over 2 indicate unpredictability, and values of -2 and lower suggest extreme predictability (redundancy, overfit of the model) and pose the question of whether other dimensions are really influencing the results [42,43].

A notable additional possibility of Rasch analysis is the analysis of graphic data. The slope of the ICC represents the discrimination, or how much the probability of giving a correct answer increases as the latent element increases (probability of providing a correct answer for those in favour of telenursing in our case).

It is possible to measure the difficulty of the questions. As the scale is dichotomous, if the point with probability 0.5 (π) (y-axis) and its corresponding location (δ) (x-axis) are determined for a question (item), easy questions will shift the sigmoid curve to the left, and—consequently—for a given δ value, the probability of answering correctly will increase. In the opposite case, the shift will be to the right.

The minimum value of the curve represents the probability of giving a correct answer by chance. It can be useful in detecting respondents who answer without even reading the questions in the questionnaire.

Graphic plotting allows analysis of the items and their degree of understanding. Information testing allows us to know what number of questions provides the highest percentage of latent characteristics.

The fact that an evaluation of 15,120 ($120 \times 21 \times 6$) responses with different profiles was carried out is one of the novelties and strengths of this work, as practically all possible future response trends in a real population have been covered. In terms of limitations and future projection, the most notable aspect of the study is that no responses were obtained from actual nurses, leaving the field open for future research.

5. Conclusions

Both the CTT and IRT approaches, considering the specificities and the specific design of the questionnaire, confirm the validity of this test to assess nurses' positioning in relation to telenursing.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/math10142463/s1.

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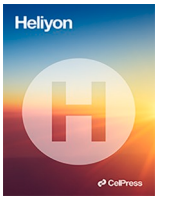

Telenursing: The view of care professionals in selected EU countries. A pilot study

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ABSTRACT

Background: With the growth of digital nursing, several studies have focused on recording patients' views on remote care, or specialised nurse staffing aspects. This is the first international survey on telenursing focused exclusively on clinical nurses that analyses the dimensions of usefulness, acceptability, and appropriateness of telenursing from the staff point of view.
Methods: A previously validated structured questionnaire including demographic variables, 18 responses with a Likert-5 scale, three dichotomous questions, and one overall percentual estimation of holistic nursing care susceptible to being undertaken by telenursing, was administered (from 1 September to 30 November 2022) to 225 clinical and community nurses from three selected EU countries. Data analysis: descriptive data, classical and Rasch testing.
Results: The results show adequacy of the model for measurement of the domains of usefulness, acceptability, and appropriateness of telenursing (overall Cronbach's alpha 0.945, Kaiser-Meyer-Olkin 0.952 and Bartlett's $p < 0.001$). Answers in favour of telenursing ranked 4 out of 5 in Likert scale, both globally and by the three domains. Rasch: reliability coefficient 0.94, Warm's main weighted likelihood estimate reliability 0.95. In the ANOVA analysis, the results for Portugal were significantly higher than those for Spain and Poland, both overall and for each of the dimensions. Respondents with bachelor's, master's and doctoral degrees score significantly higher than those with certificates or diplomas. Multiple regression did not yield additional data of interest.
Conclusions: The tested model proved to be valid, but although the majority of nurses are in favour of telenursing, given the nature of the care, which is mainly face-to-face, according to the respondents, the chances of carrying out their activities by telenursing is only 35.3%. The survey provides useful information on what can be expected from the implementation of telenursing and the questionnaire proves to be a useful tool to be applied in other countries.

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1. Introduction

There are four key drivers for the rapid expansion of information and communication technologies (ICT) in virtual care. Technological advances, particularly in health informatics [1,2] contributing to a better systematisation, quality control, and self-assessment of care [3–5]; a societal demand for equity of access [6] and for greater attention to be paid to the ageing population or to those living in remote areas [7]; labour shortage of nursing and midwifery personnel, which is predicted to worsen in the coming years [8], and cost-effectiveness constraints [9,10].

Although etymologically telenursing implies any kind of holistic remote care (e.g., ordinary mailing), it usually refers to care administered through some form of ICT system, from email, telephone, chat, or messaging [11–13] to incorporating computer-based videoconferencing, remote monitoring or diagnosis, or the use of remote widgets requiring complex technologies [14,15].

The various telenursing experiences published in different articles, and in few existing monographs to date [14,16], analyse aspects from the patient's perspective [17] or from that of a specific nursing speciality [18–23], staff management, or promotion [4,24,25].

There is a lack of a comprehensive practical nursing assessment of the intention to use telenursing that covers practicing nurses both with and without experience in virtual care. Hopefully, our work will not only be useful for nursing care staff, but also for guiding the process of change towards digital care and reinforcing nurse participation in managerial decisions.

This cross-sectional survey aims to fill this gap by analysing the positioning of nurses from three selected EU countries in relation to remote care. The study of telenursing from the nurse's point of view, presented in this paper, has not been addressed (to our knowledge) in a comprehensive and global approach before [26,27].

2. Material and method

We present a cross-sectional survey (1 September to 30 November 2022) in which 225 practicing nurses from three selected EU countries (Spain, Portugal, and Poland) participated, to test their opinion regarding telenursing.

A previously validated structured questionnaire created using computer simulation [28] was self-administered, either on paper or online, which included demographic data, 18 responses (Q11−Q36) (three paired questions for each dimension) on a Likert-5 scale, three dichotomous questions (D1−D3) (one per dimension), plus an open-ended response with an overall percentage estimate of the holistic nursing care that telenursing could provide. Respondents included nurses and auxiliary nurses practicing in community centres, hospitals, or nursing homes, excluding staff involved in teaching, research, or management.

In addition to general demographic statistics, both overall and by country, the results of the polytomous questions (Q11-Q36) are

Table 1
Demographic data.

	Spain	Portugal	Poland	ALL
(*n*)	90	60	75	225
Age (Average, years)	43.6	41.4	32.2	39.18
(SD)	10.9	9.0	11.2	11.6
Females (%)	86.7	85.0	96.0	89.3
Years at work	16.5	18.4	9.2	14.6
(SD)	10.3	8.8	10.7	10.6
Place of Work (%)				
Hospital	84.4	65.0	98.7	84.0
Primary Care	12.2	35.0	1.3	14.7
Nursing homes	3.3	0.0	0.0	1.3
Highest professional degree (%)				
Nursing assistant certificate	*28.9*	*N.A.*	*0.0*	11.6
Nursing school diploma (3 years)	*32.2*	*N.A.*	*62.7*	33.8
Bachelor's degree in nursing (4 years)	*13.3*	*58.3*	*24.0*	28.9
Master's degree in nursing or health sciences	*21.1*	*40.0*	*8.0*	21.8
Doctorate in nursing or health sciences	*4.4*	*1.7*	*5.3*	4.0
N.A. Not applicable				
***Specialty** (Yes, %)*	*19.0*	*78.3*	65	58.8
Telenursing experience (%)				
None	84.4	86.7	89.3	86.7
Two years or less	12.2	11.7	4.0	9.3
Over two years	3.3	1.7	6.7	4.0
Polytomous answers (Likert)				
Global Median	4.0	4.0	4.0	4.0
Usefulness	4.0	4.0	3.5	4.0
Acceptance	4.0	4.0	4.0	4.0
Appropriateness	4.0	4.0	4.0	4.0
Categorical answers (Y/N … % YES)				
Usefulness (D1)	84.4	100.0	90.7	90.7
Acceptance (D2)	84.4	100.0	86.7	89.3
Appropriateness (D3)	70.6	85.0	58.7	70.5
Estimation for telenursing use (%)	33.5	36.3	34.5	34.3

presented in graphical format. The answers were reordered and re-sorted where necessary, as questions were disordered and in some cases inverted, to avoid leading questions [28]. Additionally, to detect inconsistent answers, the theoretical value of each of the three dichotomous variables (D1-D3) was calculated for each domain as the sum of the six (three pairs) values. Score was set as 1 for sums over 15. Inconsistency was considered to be found when there was a discrepancy of more than one value between reported categorical values and the theoretical values computed as above. Discrepancies were confirmed with *p*-values in Rasch person data.

Calculations were performed with the IBM-SPSS statistics package V26 for Classical Test Theory (CTT) [29]. For Item Response Theory (IRT), a Rasch analysis was performed with R (basic packages: MASS, eRm, Itm, TAM), obtaining the reliability ratio, and Warm's mean weighted likelihood estimates (WLE) reliability.

A one-way ANOVA analysis was performed using the sum of the polytomous variables as the dependent variable and country, academic degree, and workplace as independent variables. Finally, multiple linear regression modelled the total score with these variables.

Rasch analysis has also been performed including inlier-sensitive or information-weighted fit (infit-t), i.e., standardized as a z-score, standardized outlier-sensitive fit (outfit-t), betas, level of difficulty, level of discrimination, The item characteristic curves (ICC) and item information curves (IIC). Expected A Priori (EAP) and Warm's likelihood estimate (WLE) reliability ratios.

3. Results

3.1. Demographic statistics

The demographics (Table 1) show some differences in the average age of nurses, with Polish nurses about one decade younger than those of the other countries, giving an overall average of 39.18 ± 11.6 years. The majority (89.3%) of respondents were female. Years in this work provided a similar difference, matching the described differences in age (18.5–9.2), with an overall average of 14.6 ± 10.7 years. Hospital workers represented 84.0%. The post-Bologna generation, with at least a 4-year bachelor's degree, is beginning to predominate (54.7%). Almost 60% have a speciality, and 86.7% have no experience with telenursing. Respondents ranked telenursing as 4 out of 5 in the Likert scale, both globally and by the three domains of usefulness, acceptance, and appropriateness.

Inconsistent careless answers were found in 16 cases (7.1%) when considering those cases where there were two or more discrepancies between the theoretical values of the categorical variables and the recorded data. It was confirmed by nonsignificant *p* values in Rasch person data. This data is in line with values reported previously [30–32].

3.2. Results for polytomous variables (Likert answers)

These are presented in summarised graphical formats. Questions Q11−Q16 correspond to usefulness, Q21−Q26 to acceptance, and Q31−Q36 to appropriateness (Figs. 1–4). Values 4–5 are predominant, indicating a positive answer.

3.2.1. Overall data (n = 225)

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3.2.2. Data from Spain (n = 90)

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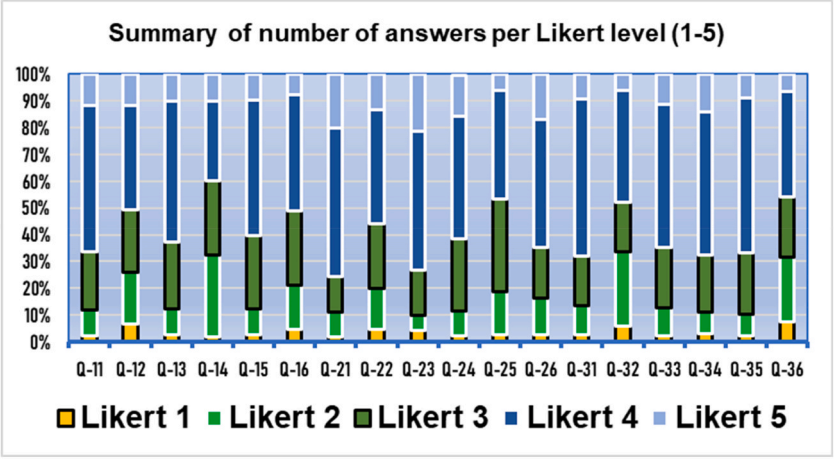

Fig. 1. Results of the three domains by polytomous (Likert) answers. Q11−Q16 usefulness, Q21−Q26 acceptance. Q31−Q36) appropriateness. Overall results (*n* = 225).

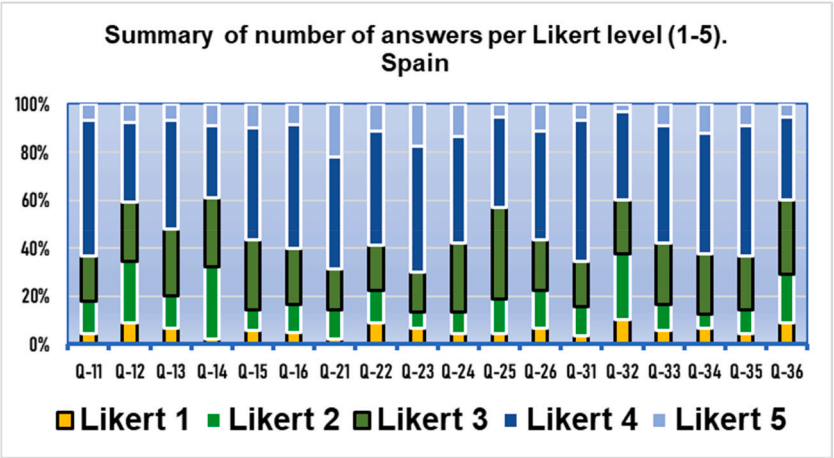

Fig. 2. Results of the three domains by polytomous (Likert) answers. Q11−Q16 usefulness, Q21−Q26 acceptance. Q31−Q36 appropriateness. Results from Spain ($n = 90$).

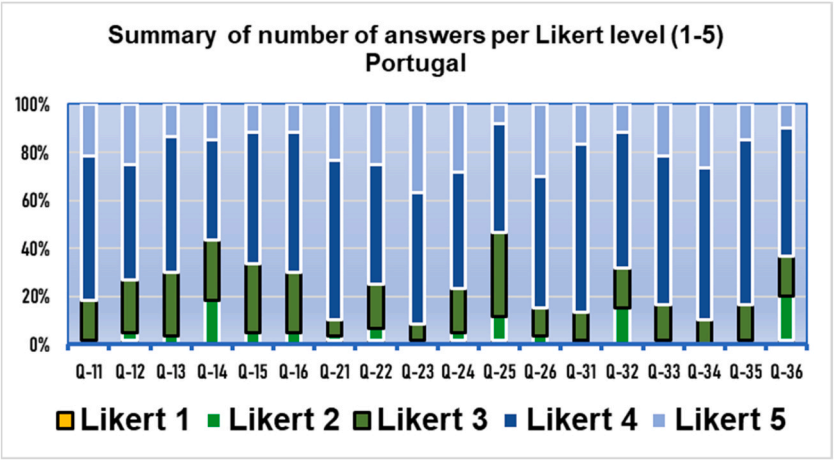

Fig. 3. Results of the three domains by polytomous (Likert) answers. Q11−Q16 usefulness, Q21−Q26 acceptance. Q31−Q36 appropriateness. Results from Portugal ($n = 60$).

3.2.3. Data from Portugal (n = 60)

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3.2.4. Data from Poland (n = 75)

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3.3. ANOVA results

An ANOVA analysis was performed to determine how the different parameters condition the total sum of the polytomous variables. The respondent characteristics that were significant in the ANOVA were: country, degree, and place of work. The scores obtained by respondents from Portugal are significantly higher than those from Spain and Poland, both for the total sum and for each of the dimensions. It should be noted, however, that there is no nursing assistant category in Portugal. Regarding the degree variable, groups 3, 4 and 5 (Bachelor, Master, and Doctorate) score significantly higher than groups 1 and 2 (certificate and diploma) (Table 2).

3.4. Multiple linear regression statistical results

Multiple linear regression of the total score explains 14.7% of the variability. Age was not significant. The variables compare the Portugal group versus the rest (Spain and Poland), degree 3, 4 and 5 versus 1 and 2 and hospital as place of work versus primary care. All have been entered as two-level dummy variables and the 3 respondents from nursing homes were excluded. The mean score:

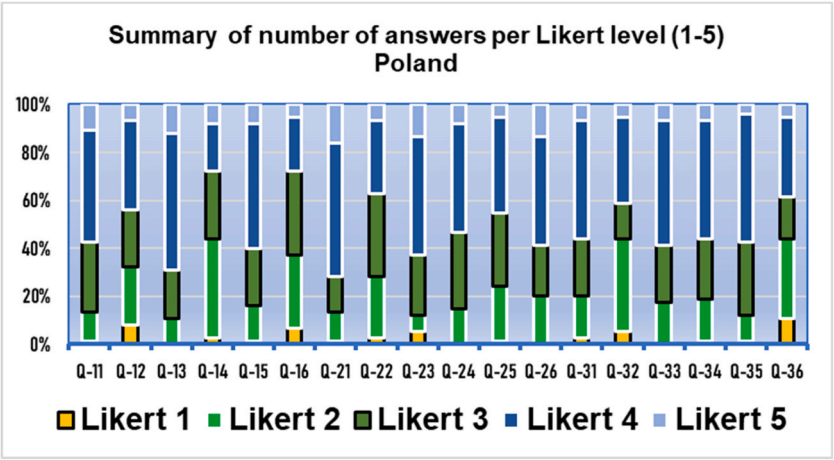

Fig. 4. Results of the three domains by polytomous (Likert) answers. Q11−Q16 usefulness, Q21−Q26 acceptance. Q31−Q36 appropriateness. Results from Poland ($n = 75$).

Table 2
Kruskal-Wallis tests.

	Sample size (n)	Average rank	Confidence intervals (95.0%)		
			Contrast	Difference	+/− Limits
Country					
Poland (PL)	75	93.24	PL - PT	−57.435[a]	26.992
Portugal (PT)	60	150.68	PL - SP	−11.110	24.365
Spain (SP)	90	104.35	PT - SP	46.325*	25.973
$H = 28.6313$ $p < 0.000001$	PL - PT	−57.435	*	26.992	
Place of work					
Hospital (H)	189	105.86	H–N	−15.1429	90.685
Nursing home (N)	3	121.00	H–P	−47.3247[a]	29.401
Primary care (P)	33	153.18	N–P	−32.1818	93.974
$H = 14.9121$ $p < 0.001$					
Degree					
1 Certificate	26	74.269	1–2	−20.4939	41.5155
2 Diploma	76	94.763	1–3	−58.4077[a]	42.4014
3 Bachelor	65	132.677	1–4	−56.6287[a]	44.3353
4 Master	49	130.898	1–5	−65.0641	70.6691
5 PhD	9	139.333	2–3	−37.9138[a]	30.8709
$H = 26.3158$ $p < 0.0001$			2–4	−36.1348[a]	33.4775
			2–5	−44.5702	64.4147
			3–4	34.5701	34.5701
			3–5	64.9892	64.9892
			4–5	66.2671	66.2671

[a] Indicates a significant difference.

increases 5.054 points on average if the respondent works in hospital versus primary care; increases 4.979 points on average if the respondent has a bachelor, master or doctoral degree versus certificate or diploma and increases 5.074 points on average if the respondent is from Portugal versus the respondents from Spain and Poland (Table 3).

Table 3
Multiple regression analysis summary.

Coefficients[a]								
Model		Unstandardised coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	58.128	1.183		49.148	.000	55.853	60.460
	place	5.054	2.342	.143	2.158	.032	0.824	9.578
	degree	4.979	1.878	.197	2.651	.009	1.275	8.602
	Portugal	5.074	2.195	.179	2.311	.022	0.744	9.325

[a] Dependent variable: Total score.

3.5. Classical theory results

Following our previous methodology, Table 4 summarises the non-standardised Cronbach's alpha of the polytomous variables for each database (based on covariance analyses) for each dimension. The 95% confidence intervals (CI) for Cronbach's alpha have been computed using the interclass correlation coefficients (two-way random consistency) model. Principal component analysis was performed to assess the strength of the partial correlation between the items, with Kaiser-Meyer-Olkin (KMO) and Bartlett's tests. All Cronbach's alpha excluding one question are over 0.94. Best exclusion is for question Q14 ($\alpha = 0.951$).

3.6. IRT. Rasch analyses

The results are summarised in the following table (Table 5).

In addition to the EAP, WLE reliability scores, a complete Rasch test was performed for the categorical variables, although its value considering only three categorical questions cannot be taken into account alone.

The following graphics, included in Fig. 5, depict the Item Characteristic Curves (ICC) and the Item Information Curves (IIC) for categorical (D1−D3) variables.

The IIC and ICC curves are used to assess the internal consistency of the Rasch data. The ICC curve measures the reliability of the measurement and assesses whether the measurement instrument is reliable in measuring the desired construct. The slope of the ICC represents how much the probability of giving a positive answer increase for supporters of telenursing.

There is a left displacement of the ICC, particularly for usefulness and acceptance. This is probably due to a high degree of 'ceiling' effect, meaning that the items are too easy for the majority of the test takers, together with an unequal distribution of scores, resulting in a large number of test takers scoring at the same (positive) level. An average respondent has a probability over 90% in all the cases.

The IIC peak at the difficult value (highest discrimination of the item). It provides information on how much 'information' about the latent trait ability is given by an item. The curves are again left biased. The most likely reason for the left shift of the IIC Curves is that the items are too easy for the group of test subjects.

The real value of the Rasch analyses rely on the reliability coefficients for polytomous questions (0.94–0.95).

4. Discussion

Technological factors, increase in community needs, severe staff shortages and cost effectiveness will drive the growth of telenursing, which needs to include the vision of nurses and their active participation in the design and implementation of the programme as essential elements for success [33,34]. Often, organisational changes in health care start from the upper levels of management, with a top-down approach, where not infrequently the professional community is ignored. This leads to delays, if not the abandonment of the new procedure [33,34].

As reported, our questionnaire [28] has been inspired by previous experiences of healthcare staff already teleworking [35–38]; by general questionnaires on the incorporation of technologies [39,40]; and by a previous design focusing on patients' behaviour towards telenursing (TISQ) [17].

Taking these previous experiences into account, and focusing on eliciting the essential elements [41], careful attention has been paid to avoid the frequent error of leading questions [42]. Therefore, each question is paired with an opposing question and the pairs were randomly unordered so that the questions cannot be answered routinely. This allows testing for consistency.

Following the philosophy of the TSQ questionnaire, designed specifically for telemedicine systems, it is assumed that the equipment will be used by patients and professionals once it has been installed and tested, so technical questions relating to the interface have not been included. However, some related aspects have been included, inspired by the TAM, a questionnaire not specific to health sciences but widely used in the commercial world and which includes questions related to usability factors of usefulness and ease of use [39,40].

Details on Classical Test Theory methodology (for polytomous variables) can be found in our previous work [28]. Cronbach's alpha, KMO and Bartlett's tests confirm the adequacy of the results. Overall, Cronbach's alpha is very high (0.945), with interclass correlation of 0.940. KMO 0.952 and Bartlett $p < 0.001$ (Table 4).

The Kaiser-Meyer-Olkin Sphericity Test (KMO) assesses the correlation between variables and determines whether the data set is adequately related to apply dimensionality reduction. This means that it measures the degree to which a set of variables is related to each other. A KMO score above 0.6 indicates that the set of variables is sufficiently related to perform a factor analysis.

Bartlett's test of sphericity (Bartlett's method of covariance and varimax rotation) tests whether the correlation matrix is an identity matrix. It is used to determine whether variables in a data set were correlated. It tests the null hypothesis that all of the variables are uncorrelated against an alternative hypothesis of at least one pair of variables being correlated. If p is not significant, principal

Table 4
Principal component tests for polytomous variables by domain and overall.

Domain	Cronbach's alpha	Interclass correlation	Interval (95%CI)	KMO	Bartlett
Usefulness (D1)	0.785	0.785	0.739–0.826	0.819	<0.001
Acceptance (D2)	0.878	0.878	0.851–0.901	0.884	<0.001
Appropriateness (D3)	0.883	0.883	0.857–0.905	0.871	<0.001
Overall	0.945	0.945	0.934–0.955	0.952	<0.001

Table 5
Summary of Item Response Theory data (Rasch test).

Variables	Index	Value	
Dichotomic	EAP reliability.	0.52	●The reliability score test to characterize the latent factor structure of the set of binary and ordered-category variables
	WLE reliability.	−0.49	
	Andersen LR test	22.32	● Andersen likelihood ratio test for the goodness of fit of the Rasch model.
	p	0.81	
	D1-Infit-t	−1.07	●The measurement of infit and outfit in Rasch analysis refers to the ability of the data to fit a measurement model. The infit refers to the fits of the data to the expected distribution. Infit values are often used to detect anomalous patterns in the data, such as erroneous responses or over-responses. Outfit values, on the other hand, are used to assess the predictive ability of the data. It refers to the fits of the data to the structured, default distribution.
	D2-Infit-t	−2.84	
	D3-Infit-t	−2.03	
	D1-Outfit-t	−1.12	
	D2-Outfit-t	−2.75	
	D3-Outfit-t	−3.09	●Standardised infit and outfit (-t or Z) acceptable values range −1.9 to +1.9. Over 2 data are unpredictable. Data under −2 are too predictable.
	Beta-D1 (0.95CI)	−1.39	
	Beta-D2 (0.95CI)	−0.91	
	Beta-D3 (0.95CI)	2.29	
	D1-Dffclt	−1.40	●Dffclt and Dscrm are both measures of difficulty in Rasch analyses. Both measures can be used to assess the difficulty level of a particular item, as well as the ability of individuals to respond to different difficulty levels. Dffclt is the difficulty level of a particular item on a measure, and Dscrm is the ability of an individual to discriminate between items of different difficulty levels.
	D1-Dscrmn	4.56	
	D1-P(x = 1|z = 0)	1.00	●P(x = 1|z = 0) is the probability that a person with a z-score of 0 will have an x-score of 1. This probability is determined by the person's ability level and the difficulty of the item. In this case the probabilities are around 1 in the three cases.
	D2-Dffclt	−1.31	
	D2-Dscrmn	4.56	
	D2-P(x = 1|z = 0)	1.00	
	D3-Dffclt	−0.53	
	D3-Dscrmn	4.56	
	D3-P(x = 1|z = 0)	0.92	
Polytomous	EAP reliability.	0.95	
	WLE reliability.	0.94	

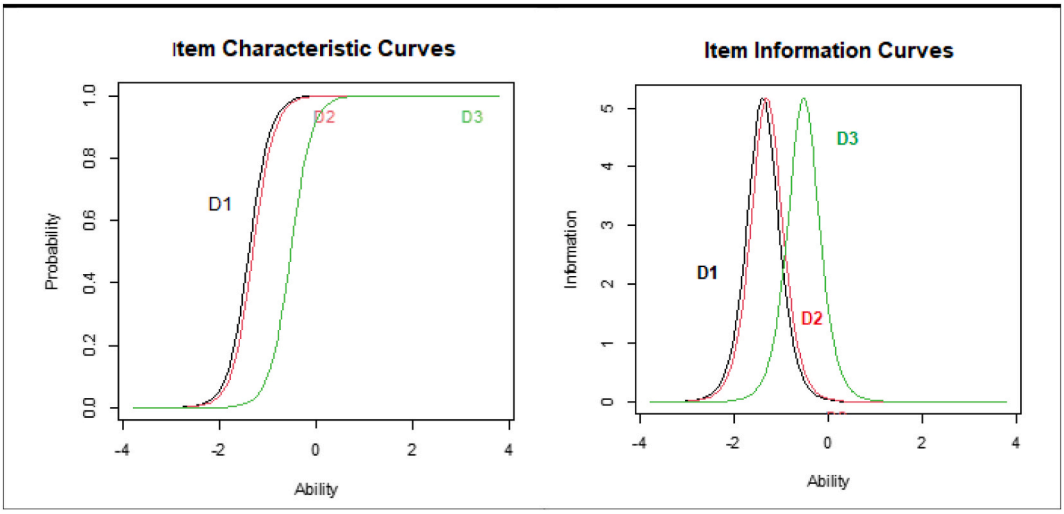

Fig. 5. Item Characteristic Curves (ICC) and the Item Information Curves (IIC) for categorical variables.

component analysis is not appropriate.

As expected with IRT analysis when considering a construct with only three categorical variables, the EAP reliability is 0.52, indicating an insufficient fit of the Rasch model when only dichotomous variables are included; this is confirmed by WLE of −0.49. Therefore, polytomous analysis is imperative, or else a new design of the test with no less than six categorical questions per domain should be included. In other words, the short version of using only dichotomous questions is not appropriate. The dichotomous variables provide usefulness, basically when tested against the theoretical expected values D1T−D3T obtained from Likert responses for testing careless (inconsistent) answers.

The real utility results of the IRT analysis to be evaluated for polytomous variables is the EAP reliability of 0.95, indicating that the rating scale fits the underlying Rasch model very well. It has been described that there are no major differences between different likelihood estimates (LE) approaches [43]. We have used the Warm's likelihood estimate (WLE), again providing a very good result (0.94).

Although telenursing is a promising technique and will undoubtedly be implemented progressively, the results obtained show that, according to the average of the responses obtained, the degree of application to nursing care will be limited due to the fundamentally face-to-face component of the professional activity.

This study has some limitations. The survey has been carried out in three EU countries. It remains to be analyzed in the future whether the results obtained can be replicated in other contexts and health systems, particularly in developing countries and in non-public health systems.

5. Conclusions

The results are not unexpected. Most nursing care needs face to face activities, but even so, there is a substantial part of the activity that practicing nurses consider may be covered by e-nursing.

It is not necessary for a telenursing programme to start with a complex computer system that allows for comprehensive patient care, management, quality control and includes a decision tree. Dedicating a few hours of professional activity to telephone (and/or video telephonic) care through an appropriately designed programme in collaboration with nursing, could be a perfectly reasonable start.

This questionnaire meets the expected objective as a starting tool to guide the process of change towards digital care and reinforcing nurse and patient participation in managerial decisions in three selected countries and could be extended to analyse the issue in the rest of EU countries.

As for the future, unless complex Rasch developments for polytomous variables are to be used, consideration could be given to transforming these questions into a series of categorical variables to facilitate Rasch analysis.

This pilot study proves that this questionnaire is robust and allows separate analysis of the three domains (usefulness, acceptability, and appropriateness). Categorial data should not be used alone, but in conjunction with polytomous data. Results show a favourable opinion from nurses about telenursing, although they consider that appropriateness for providing holistic nursing care is limited (34.3%).

6. Summary table

What was already known on the topic?

- The various telehealth experiences analyse aspects from the patient's or from the doctor's perspective. In telenursing, only aspects of a specific nursing speciality or aspects of management and teaching have been analyzed.
- The implementation of a telenursing programme requires knowledge of the acceptance, usefulness, and appropriateness of the programme by the personnel who will use it. This information was missing.

What did this study add to our knowledge?

- The development and validation of a questionnaire to analyse telenursing.
- Acceptance of telenursing is generally high among nursing staff, although it is not the same in all countries and is mostly related to the nurse's academic level, regardless of age. Even considering all aspects (holistic approach), telenursing, according to the respondents, is only applicable in about one third of the nursing procedures.

Author contribution statement

Julio Emilio Marco-Franco: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Ramón Camaño-Puig: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Margarida Reis-Santos: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Isabel Barrachina-Martinez: Performed the experiments; Analyzed and interpreted the data.

Alina Jurewicz: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e16760.

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