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Stratifying the population based on health risk: identification of patient key health risk factors through consensus techniques

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Abstract

Background Risk stratification is a population health management approach that classifies patients according to their health risks and projected care needs. This strategy is especially valuable in primary care, where timely interventions for high-risk individuals can lead to better health outcomes, reduced healthcare expenditures, and a more sustainable healthcare system. The goal of this study was to establish expert consensus on the clinical and sociodemographic patient factors that should be incorporated into a primary care risk stratification tool.

Methods A multidisciplinary expert panel of 24 healthcare professionals, including primary care providers (PCPs), specialists, and allied health professionals, was convened in June 2024 by Local Health Authority of Parma, Italy. Using the Nominal Group Technique, the panel was asked to define 'health risk' and identify contributing factors based on clinical and social relevance and data availability in patients' PCP electronic medical records. A modified Delphi process, following ACCORD guidelines for consensus-based methods, was conducted in three rounds (July–October 2024) to derive numerical weights for the factors. Survey questions rated the perceived importance of factors using a Likert scale (1 = no importance to 9 = critical importance). Consensus, defined as $\geq 75\%$ agreement among panelists, set each factor's weight to the median importance rating.

Results Health risk was defined as "the likelihood of a progressive deterioration of an individual's health status due to medical and/or psychosocial-welfare conditions that could lead to hospitalization or death within a year." A total of 31 clinical and social factors were identified, and consensus about importance was achieved for all factors. Higher-weighted factors included advanced age, excessive polypharmacy, cancer, cognitive impairment, and social-psychological distress, followed by clinical conditions such as renal failure, stroke, and heart failure, and previous hospitalizations and emergency room visits.

Conclusions The tool provides a robust framework for population health risk stratification in primary care, aligning with Italy's healthcare reform goals. Future phases will validate the tool's predictive performance using patient-level PCP data and assess its implications for policy and practice.

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Keywords Risk stratification, Primary care, Population health management, Consensus methods, Delphi, Nominal group technique, Health risk factors, Sociodemographic risk factors

Introduction

Risk stratification is a population health management strategy that categorizes patients based on their health risks and anticipated healthcare needs [1]. This approach is invaluable to healthcare managers and providers, allowing them to identify high-risk patients, including those with chronic diseases, multiple comorbidities, or complex social determinants of health. By prioritizing risk levels and tailoring interventions accordingly, healthcare systems and providers can allocate resources more effectively, reduce acute care episodes, and enhance patient outcomes. Risk stratification is particularly beneficial in preventive care, where early interventions for high-risk groups may contribute to improved health outcomes, lower healthcare costs, and a more sustainable healthcare system. Additionally, it serves as a critical tool for guiding both individual clinical decisions and broader health policies aimed at optimizing population health [2].

Italy's healthcare system, known as the *Servizio Sanitario Nazionale* (SSN), is a publicly funded national health service established in 1978. Rooted in the principles of universality, equity, and solidarity, it ensures access to healthcare services for all Italian residents (including legally residing foreigners) funded through general taxation [3]. The SSN operates under a decentralized model across 20 regions, each with significant autonomy to implement health services that align with national objectives while addressing local needs [4]. In each region, geographically defined Local Health Authorities (LHAs) play a critical role in organizing and delivering healthcare at the local level, ensuring that services align with regional policies and population needs.

Recent reforms, including Ministerial Decree 77 and the National Recovery and Resilience Plan (PNRR), emphasize integrated care, particularly through enhanced outpatient and community-based services. These reforms aim to strengthen regional healthcare networks and promote proactive population health approaches, which are crucial in regions with aging populations and rising chronic disease prevalence [5]. Consequently, the Italian healthcare system is increasingly focused on risk stratification as a strategy to identify and manage vulnerable populations effectively and equitably [6].

The Emilia-Romagna region provides healthcare services to approximately 4.5 million inhabitants and has heavily invested in community-based healthcare models, such as medical homes and community hospitals, emphasizing integrated services to improve continuity of care and address complex health needs [7]. The LHA of Parma, one of the eight LHAs in Emilia-Romagna, serves

a population of about 450,000 inhabitants and has been at the forefront of regional medical home initiatives and the integration of risk stratification tools to deliver patient-centered care [8, 9]. In alignment with this mission, the Parma LHA, in collaboration with the University Hospital of Parma, (*Azienda Ospedaliera Universitaria*), has launched an initiative to develop a risk stratification tool to support health planning for primary care physicians (PCPs). This collaboration aims to establish a data-driven framework that aligns with national and regional health reforms, particularly in addressing the needs of high-risk, multi-comorbid, and elderly populations served by PCPs in the Parma LHA.

The development and validation of this risk stratification tool consists of three phases: (1) identifying patient clinical and sociodemographic factors relevant to risk stratification in primary care; (2) developing the tool and evaluating its performance using PCP patient data, including reliability and validity in measuring patients' risk levels; and (3) assessing the extent to which the tool provides PCPs with actionable insights for case or disease management interventions. This paper describes the first phase of the research project, which aimed to achieve expert consensus around the patient clinical and sociodemographic factors to be included in a risk stratification tool for primary care.

Methods

Ethical approval

The Thomas Jefferson University Institutional Review Board (IRB) reviewed this study and determined it does not constitute human subjects' research.

Study design

This study, conducted between May and October 2024, employed a mixed-method design (Fig. 1). The consensus-seeking approach used to identify patient factors to be included in the risk stratification tool involved two phases: 1) a Nominal Group Technique to gather subject-matter expert opinions on defining health risk within the context of primary care and identifying key factors influencing health risk, and 2) a modified Delphi method to determine the relative importance of these factors for inclusion in the tool.

Expert panel

A multidisciplinary panel of 24 experts was invited by the Parma LHA to participate in this study based on their recognized academic and clinical credentials. The panel included PCPs ($n=10$); specialists in internal medicine

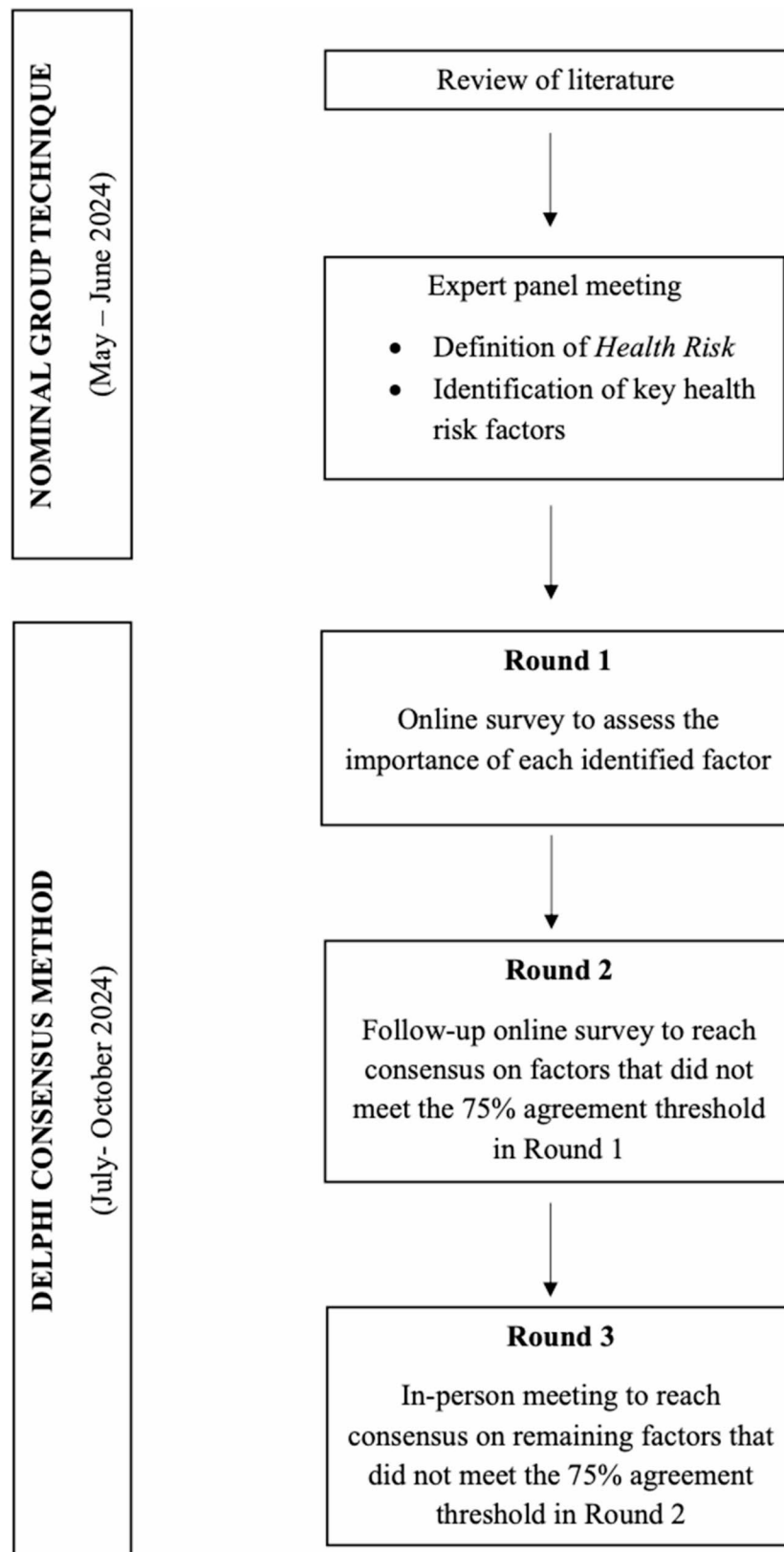


Fig. 1 Flowchart to develop a consensus-based framework to identify patient clinical and sociodemographic factors for inclusion in a primary care risk stratification tool

($n=4$), geriatric medicine ($n=1$), pulmonology ($n=1$), emergency medicine ($n=1$), infectious disease ($n=1$), cardiology ($n=2$), and psychiatry ($n=1$); nurses ($n=2$); and a pharmacist ($n=1$). The median age group was 50–59, which was also the modal age group, and there was an equal proportion of female and male participants (Table S1). Each panelist contributed insights based on their expertise. All participants were informed about the purpose of the study, the anonymous nature of data collection, and voluntarily provided verbal consent to participate.

Phase 1: Defining health risk and identifying key factors

A Nominal Group Technique was used to define health risk and identify relevant factors. [10, 11]. The Nominal Group Technique is a structured method for facilitating group decision-making and prioritization, in which participants independently generate ideas, discuss them in a controlled setting, and systematically rank or vote on them to achieve consensus. By minimizing the influence of dominant individuals and promoting equal participation, this method is particularly effective for identifying key issues and setting priorities in healthcare, research, and policy.

In June 2024, the Parma LHA convened an in-person meeting where panelists were presented with background information, study objectives, and findings from a literature review on the subject. The literature review covered well-established tools for risk stratification and comorbidity assessment, such as the Charlson Comorbidity Index [12], the LACE Index [13], and validated prognostic models for community-dwelling older adults [14–16], as well as instruments identifying older individuals at higher risk of adverse drug outcomes or death [17, 18]. These sources informed the development of an initial list of candidate health risk factors, which was subsequently reviewed and refined by the panel. Panelists were then asked to: (1) define health risk in the context of a primary care risk stratification tool, and (2) select and prioritize relevant health risk factors to finalize the list.

Phase 2: assessing the importance of risk factors

To determine the relative importance of the identified risk factors, a three-round modified Delphi method was implemented between July and October 2024 [10]. The Delphi method is a structured, iterative process for achieving expert consensus on complex issues [19]. The process involves multiple rounds of surveys where experts anonymously rate or rank items, with feedback provided after each round. Participants review this feedback and adjust their responses, promoting convergence toward a shared understanding or consensus [20]. Previous research has used variations of the Delphi method to support the development of risk stratification tools

[21–24]. A predetermined 75% agreement threshold was used to establish consensus [25–27]. All panelists participated in subsequent rounds unless they failed to respond after repeated invitations [25–33].

In Round 1, an electronic survey was distributed on July 1st to panelists via secure, commercial survey software (Qualtrics[®]). The survey remained open for six weeks (Appendix A, Supplementary material). Panelists were asked to assess the perceived importance of each risk factor on a 9-point Likert scale (1=no importance, 9=of critical importance) [34]. Panelists could also mark a factor as “not applicable” if they felt the factor was outside their expertise. A free-text box allowed panelists to provide comments or suggest additional factors.

The collected data were analyzed by calculating the median and interquartile range (IQR) for each factor. Responses were grouped into three categories: low importance (1–3), moderate importance (4–6), and high importance (7–9). A factor was considered to have reached consensus if at least 75% of responses fell within a single category.

In Round 2, a second Qualtrics © survey was administered on August 30th for two weeks to reassess factors that did not achieve the 75% agreement threshold in Round 1. Panelists who rated these factors outside the IQR calculated during Round 1 received an individualized survey. They were shown their previous scores alongside the median score for each reassessed factor, and they were asked whether they wished to adjust their scores or retain them. The data collected for each reassessed factor during Round 2 were analyzed by calculating the median and IQR for each factor. The panelists' ratings were categorized following the same approach as in Round 1.

A final in-person session at the Parma LHA was held on October 2nd to discuss and reach consensus on the remaining factors that had not met the 75% agreement threshold. For each of the remaining factors discussed during this session, median and IQR calculated during Round 2 were presented, followed by a structured discussion to achieve final consensus.

All data processing and analyses were conducted in R (R Core Team, 2023) [35]. The study adhered to the ACCORD guidelines for consensus-based research [36].

Results

Phase 1: nominal group technique results

The panel agreed that health risk assessment in primary care should prioritize individuals based on their levels of health risk in relation to medical and social determinants of health, which would help to ensure the use of targeted interventions that prevent or delay disease progression. The panel defined health risk as: “*The likelihood of a progressive deterioration of an individual's health status due*

to medical and/or psychosocial-welfare conditions that could lead to hospitalization or death within a year.”

Building on this definition, the panel reviewed the initial list of risk factors compiled by the research team based on findings from the literature. Through one single Nominal Group session, including individual idea generation, a round-robin sharing and clarification phase, and a final voting exercise, the panel refined the list of factors by evaluating the clinical relevance, practical utility, and availability of data for the factors within the PCPs' electronic health record system. This process led to a final selection of 32 factors, encompassing a total of 42 items (Table 1). For instance, the factor 'age' was broken down into six distinct items representing different age groups: <50, 50-59, 60-69, 70-79, 80-89, and 90+. Additionally, the panel retained all the initial medical conditions retrieved from the literature and added schizophrenia, connective tissue diseases, and urinary incontinence. The finalized factors were categorized into three domains: patient characteristics ($n=8$), healthcare resource utilization ($n=5$), and clinical conditions ($n=19$).

Phase 2: modified delphi method results

In the first Delphi round, all participants completed the survey (Table S1). Consensus, defined as $\geq 75\%$ agreement, was reached for 20 of the 42 items (Table S2). Items receiving the highest importance scores (median=9) included age ≥ 90 , age 80–89, polypharmacy (≥ 10 medications), dementia, cancer in the previous three years, heart failure, and BMI >30 (Table 2).

In the second Delphi round, all 24 participants were invited to complete a follow-up survey to reassess the 22 items for which consensus was not achieved in the first round. Participants reconsidered items that they had previously rated outside the IQR during Round 1. Each participant reviewed between 1 and 15 items (Table S3), with a median of 5.5 items and a standard deviation of 4.2. A total of 20 participants completed this round (Table S1). Consensus was achieved for 11 additional items, among them being age 70–79, prior hospitalizations, polypharmacy (5-9), and BMI <18 that received a median importance score of 8 (Table S4). However, consensus on importance was not reached for 11 items, among them being schizophrenia, rheumatoid arthritis, and depression.

In the final, in-person Delphi round, one research team member (VM) facilitated a structured discussion to resolve disagreement about the remaining 11 items. A total of 20 participants completed this round (Table S1). This session lasted 2 hours and 30 minutes. The results of the previous rounds, including the factors' median scores and IQRs, were presented to the panel. Consensus ($\geq 75\%$ agreement) was systematically sought through structured debate, allowing participants to justify their

ratings. By the end of the session, after a thorough discussion, consensus was achieved for all remaining items (Table S5). The panel agreed that all median values containing decimal points would be rounded down to the nearest whole number. Notably, the expert panel confirmed consensus for most items by retaining the median importance scores from Round 2. However, consensus was reached for depression and BMI 25-30 by increasing their importance scores from 6 to 7, and for Type I diabetes and age <50 by decreasing their scores from 7 to 6 and from 4 to 2, respectively. Since the factor sex received equivalent importance score for both male and female categories, it was removed from the final list.

Table 2 summarizes the final scoring of the selected 31 factors, encompassing 40 items. Of these, 29 were classified as having high importance, 10 as having moderate importance, and 1 as having low importance.

Discussion

The aim of this study was to develop a framework for primary care health risk by way of implementing a consensus-based process to identify patient clinical and sociodemographic factors that will serve as components for a primary care health risk assessment stratification tool. Using a combination of the Nominal Group Technique and a multi-round modified Delphi method, we successfully achieved expert consensus on both the definition of health risk and the relative importance of a comprehensive list of risk factors. Overall, the study's objectives were met, demonstrating the feasibility and utility of consensus-based approaches for identifying relevant components for health risk stratification in primary care settings [10;11].

In the first instance, the panel reached consensus on a practical definition of health risk in primary care. The adopted definition—*“The likelihood of a progressive deterioration of an individual's health status due to medical and/or psychosocial-welfare conditions that could lead to hospitalization or death within a year”*—reflects a deliberate operationalization that captures both medical and social determinants of health. This definition is aligned with existing research literature that emphasizes the multifactorial nature of health risk, integrating traditional clinical markers with sociodemographic and psychosocial factors [1, 12].

The panel also reached consensus on a set of health risk factors for which data are readily accessible from patients' electronic medical records in primary care. These factors span patient demographics and personal habits, healthcare resource utilization, and clinical conditions. Importantly, the list of factors recommended by the panel includes several predictors incorporated in established health risk stratification tools that utilize administrative healthcare data [9, 37, 38]. What distinguishes the

Table 1 Health risk factors identified by the expert panel

Factor	Item	Definition
<i>Patient characteristics</i>		
Age	· < 50 · 50–59 · 60–69 · 70–79 · 80–89 · 90+	
Sex	F/M	
Alcohol consumption		Pathologic/Dysfunctional
Cigarette smoking	· Current smoker · Former smoker	
Body Mass Index (BMI)	· < 18 underweight · 25–30 overweight · > 30 obese	
Motor abilities		Motor capacity impairment that requires external assistance
Cognitive impairment		
Socio-psychological distress		Social services activated or submitted request of activation for socio-psychological distress
<i>Healthcare resource utilization</i>		
Hospitalization		At least 1 hospitalization in the previous 12 months
Emergency room		At least 1 ER access in the previous 12 months
Polypharmacy	· 5 to 9 different drugs in the previous year · 10 + different drugs in the previous year	
Inappropriate medication exposure in subjects 65 + years: NSAIDs use for > 15 days in the last month		
Integrated Home Care		
<i>Clinical condition</i>		
Arterial hypertension		
Cancer (in the previous 3 years)		
Connective tissue diseases		
COPD (emphysema, chronic bronchitis)		
Coronary artery disease, Infarction (ischemic heart disease)		
Chronic liver disease or cirrhosis		
Chronic renal failure		
Chronic respiratory failure		
Dementia		
Depression		
Femur fracture		
Heart failure		
Psoriasis		
Rheumatoid arthritis		
Schizophrenia		
Stroke		
Type I Diabetes		
Type II Diabetes		
Urinary incontinence		

Table 2 Final consensus on the importance of health risk factors

Factor/item	Score	Importance
Age > 90	9	High
Age 80–89	9	
Polypharmacy (10+)	9	
Cancer in previous 3 years	9	
Dementia	9	
BMI > 30	9	
Cognitive impairment	8	
Chronic renal failure	8	
Stroke	8	
Heart failure	8	
Polypharmacy (5–9)	8	
Femur fracture	8	
Motor skills impairment	8	
Social-psychological distress	8	
Chronic respiratory failure	8	
Coronary artery disease	8	
Age 70–79	8	
Integrated home care	8	
BMI < 18	8	
Chronic liver disease or cirrhosis	8	
Current smoker	8	
COPD	8	
Hospitalization(s)	8	Moderate
Type II Diabetes	7	
Schizophrenia	7	
BMI 25–30	7	
Depression	7	
Alcohol Abuse	7	
Inappropriate meds 65+ (NSAIDs)	7	
Type I Diabetes	6	
Age 60–69	6	
Urinary incontinence	6	
Connective tissue diseases	6	Low
Rheumatoid arthritis	6	
Former smoker	6	
Emergency Room	6	
Arterial hypertension	5	
Psoriasis	5	
Age 50–59	5	
Age < 50	2	

current approach is the inclusion of socio-psychological components—such as cognitive impairment and distress—that serve as proxies for social determinants of health. Given that these factors are often underrepresented in administrative databases, their incorporation may enhance the tool's ability to capture nuanced aspects of patient vulnerability [2, 37, 38].

Consensus was also achieved regarding the relative importance of the health risk factors. As expected, older age and frailty-related indicators (e.g., femur fracture, need for integrated home care, motor skills impairment) were considered highly important. Geriatric conditions,

such as dementia and stroke, along with end-stage conditions like cancer and chronic liver, renal, respiratory, and heart failure, received strong endorsement by the panel. Notably, social-psychological distress—a non-clinical factor—was highlighted as a critical determinant. The emphasis placed on excessive medication use (i.e., polypharmacy) is supported by a growing body of evidence linking polypharmacy with adverse health outcomes and accelerated clinical deterioration [39]. This finding underscores the increasing awareness among clinicians of the detrimental effects of polypharmacy in older adults and patients with multiple comorbidities.

While the panel concluded that sex should not influence risk scoring, prior research has documented differences in health risk profiles between men and women [40, 41]. For example, women have higher rates of frailty, whereas men show a greater prevalence of cardiovascular disease—differences that are well-established in the literature. The exclusion of sex as a differentiating factor in the final list should therefore be acknowledged and considered in future evaluations.

The results have important implications for both practice and further research. From a clinical perspective, the consensus-derived list of factors supports the development of a comprehensive and practical health risk stratification tool, aiding PCPs in identifying patients at high risk for hospitalization or death. Future research should evaluate the reliability and validity of patients' health risk scores that are obtained from the tool in real-world settings. Additionally, further work could investigate whether dynamic adjustments to the risk factors (e.g., changes over time in polypharmacy or functional status) might improve the tool's accuracy.

This study has several limitations. While the expert panel was chosen to include a range of professional perspectives, the largest proportion of participants were primary care physicians, which may have affected the results. Including specialists in other clinical areas, such as oncology and urology, could have increased representativeness and obtained wider viewpoints. Moreover, the absence of professionals from social care, community health, or patient advocacy roles on the panel may have limited the identification and prioritization of social determinants of health, despite their acknowledged relevance in defining health risk. This limitation is further compounded by the reliance on data available in the PCPs' electronic health record system, where detailed and standardized information on social factors is often lacking. As a result, the panel's prioritization may have been influenced by both the composition of expertise and data availability constraints. There was some attrition in the second and third Delphi rounds, preventing us from including the perspectives of all panel members. While anonymity was maintained during the first two rounds,

the lack of anonymity during the in-person round (round 3) may have resulted in peer pressure that could have influenced the opinions of one or more participants. Additionally, presenting the initial list of factors derived from the literature review at the outset may have introduced anchoring bias, potentially limiting the range of novel suggestions from participants. This issue is a recognized limitation of structured consensus methods. However, the use of the Nominal Group Technique—which includes independent idea generation prior to group discussion—was intended to mitigate this bias by encouraging participants to formulate their own inputs before being exposed to the group-derived list. Lastly, consensus-based techniques have an inherent limitation given that other selected expert panels could have reached different conclusions.

The primary aim of this first phase of the project was to identify key clinical and sociodemographic factors essential for developing a risk stratification tool in primary care. This tool is intended to support the Parma LHA and the University Hospital of Parma in designing targeted preventive interventions for high-risk patients, in alignment with ongoing healthcare reforms in Italy. Although the selected factors and their relative importance reflect the Italian healthcare context, they may be adapted for use in other countries to inform risk stratification tools aligned with local healthcare policies. While risk stratification is a critical component of primary care, it is important to recognize that a universally applicable model is unlikely to be feasible. As such, the current instrument may serve as a flexible framework for developing context-specific tools tailored to different populations and healthcare systems.

This initial phase sets the foundation for phase 2, which will feature an evaluation of the tool's performance using patient data. The evaluation will investigate its validity and predictive accuracy in estimating patients' health risk levels. Phase 3 will then evaluate the utility of the risk stratification tool for PCPs in identifying patients who may benefit from case or disease management interventions. By establishing a framework for health risk assessment, this collaborative effort not only advances regional health initiatives but also contributes to Italy's broader objectives for improving population health and supporting high-risk, multi-comorbid, and elderly patients.

Conclusions

In summary, the expert panel successfully defined health risk and identified a robust set of factors that blend traditional clinical components with sociodemographic and psychosocial elements. These findings provide a sound basis for constructing a more holistic risk stratification tool in primary care. The consensus on factor importance suggests that future risk models could benefit

from incorporating a broader range of patient information, including aspects often missing from administrative databases.

Abbreviations

IRB	Institutional Review Board
IQR	Interquartile range
LHAs	Local Health Authorities
PNRR	National Recovery and Resilience Plan
NGT	Nominal Group Technique
PCPs	Primary care physicians
SSN	<i>Servizio Sanitario Nazionale</i>

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12875-025-02923-w>.

Supplementary Material 1.

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Authors' contributions

V.M., M.G., A.D., R.H., C.C. and A.H. designed the study. A.H., C.C., A.D., R.H., and V.M. managed the data and analyzed the data. C.C., V.M., and A.H., drafted the manuscript. A.D., R.H., M.G., and M.F. provided critical revisions to the manuscript. All authors reviewed the manuscript. The authors read and approved the final manuscript.

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Data availability

The dataset supporting the conclusions of this article is included within the article (and its additional files in supplementary material).

Declarations

Ethics approval and consent to participate

The Thomas Jefferson University Institutional Review Board (IRB) reviewed this study and determined that it does not constitute human subjects research (IRB Letter, determination date: [October 18, 2023]). As such, ethics approval and informed consent were not required in accordance with institutional policies and U.S. federal regulations (45 CFR 46). Nevertheless, the study was conducted in accordance with institutional guidelines and the principles of the Declaration of Helsinki.

Consent for publication

This study does not include any identifiable personal data from participants. Panelists' contributions were anonymized and presented in aggregate form; therefore, consent to publish is not applicable.

Competing interests

The authors declare no competing interests.

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