Psychometric Properties of the Translated Cardiovascular Disease Risk Factors Knowledge Level (CARRF-KL) in a Military Hospital Setting: Assessing Knowledge of Cardiovascular Disease Risk Factors

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Abstract. Cardiovascular disease (CVD) remains a significant public health concern in military populations. The Cardiovascular Disease Risk Factors Knowledge Level (CARRF-KL) questionnaire is used to assess knowledge of CVD risk factors and to support patient education; however, empirical evidence for its translated Bahasa Melayu version remains limited. This study evaluated the psychometric properties of the translated CARRF-KL among military personnel using the Rasch Measurement Model. A total of 100 respondents completed the 28-item questionnaire. The item reliability was high (0.93) with good item separation (3.56), indicating that the items formed a stable hierarchy of difficulty. However, person reliability was lower (0.68) and person separation was 1.47, suggesting the current instrument was not sufficiently sensitive to classify respondents into clearly distinct knowledge levels. Residual dimensionality analysis indicated that the primary Rasch dimension explained 22.4% of the variance, while the first residual contrast had 3.33, indicating areas requiring substantive review. Person-fit diagnostics identified atypical response patterns, particularly Participant 98, and item-targeting evidence suggested the need for additional higher-difficulty items and review of potentially redundant items. Overall, the translated CARRF-KL is a promising tool for identifying knowledge gaps, but further refinement and validation are required before it can be used confidently for classification of CVD risk-factor knowledge among military personnel.

Keywords: Psychometric properties, Cardiovascular disease, Military.

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1 Introduction

1.1 Background of Study

Cardiovascular disease (CVD) has emerged as the foremost global health challenge, underscored by its status as the leading cause of mortality worldwide. In 2008, CVD accounted for approximately 30% of all deaths globally, as reported by Roth et al. (2017). This alarming trend has persisted, with cardiovascular diseases continuing to claim more lives annually than any other health condition. The burden of CVD is particularly acute in low and middle-income countries, where over 80% of cardiovascular-related deaths occur, impacting both men and women nearly equally. The magnitude of this issue is further highlighted by the World Health Organization (WHO), which estimates that high blood pressure alone is responsible for 9.4 million deaths annually, constituting 16.5% of all deaths (Cohen et al. 2014). This statistic encompasses deaths from strokes and coronary heart disease, underscoring the critical need for effective management and prevention strategies for hypertension and other CVD risk factors. Projections indicate a worrying trend, with the number of deaths due to CVD, particularly heart disease and strokes, expected to escalate to 23.3 million by 2030 (Perumareddi, 2019). These figures emphasize the urgent need for targeted interventions to mitigate the impact of CVD and prevent its anticipated rise.

Malaysia, with a population of 23 million, consists of three major ethnic groups: Malays (55%), Chinese (34%), and Indians (10%). Between 1994 and 2001, cardiovascular disease was consistently the leading cause of death in government hospitals, accounting for 23% to 26% of deaths. Heart disease specifically contributed to 14% to 16.6% of admissions and deaths related to cardiovascular disease in government hospitals between 1985 and 2000, with ischaemic heart disease making up a significant portion of these statistics (25% to 33% of admissions and 27% to 35% of deaths) (Lim et al. 2000).

CVD is a critical health issue in Malaysia, significantly contributing to morbidity and mortality. According to the World Health Organization, CVD accounted for 98.9 deaths per 100,000 population in Malaysia in 2012, translating to 29,400 deaths or 20.1% of all deaths (Seong & John, 2016). The National Health and Morbidity Surveys (NHMS) have documented a troubling increase in the prevalence of cardiovascular risk factors such as hypertension, hypercholesterolemia, diabetes, overweight/obesity, and smoking. Furthermore, data from the National Cardiovascular Disease – Acute Coronary Syndrome (NCVD-ACS) Registry indicate that Malaysians are developing heart disease at a younger age compared to neighboring countries (Ministry of Health, 2019). Additionally, abnormal plasma lipid levels, such as elevated total cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglycerides, along with low high-density lipoprotein cholesterol (HDL-C), significantly increase CVD risk. Rapid urbanization, dietary shifts towards high-fat and high-sugar foods and decreased physical activity further amplify these risk factors. Addressing these issues through

public health initiatives and lifestyle modifications is crucial for reducing the global burden of cardiovascular disease (Mohd Nor et al. 2022).

Smoking is a well-recognized risk factor for numerous chronic diseases, and its impact on health, causing illness and death, constitutes a substantial public health challenge in many nations. A study was conducted to seek the information gap regarding smoking-related mortality in Malaysia by estimating the risk of cardiovascular disease and overall mortality linked to smoking among Malaysian adults. Data from 2525 participants, aged 24-64, who took part in the Malaysian Non-Communicable Disease Surveillance survey conducted from September 2005 to February 2006, were examined. The result reported the prevalence of daily smoking was 21.2% (95% CI: 19.0-23.7). Over the 31668 person-years of follow-up, 213 deaths occurred from all causes, with 68 of those deaths occurring among smokers (13.2%), and 452 among non-smokers (6.3%). Smoking was linked to a significantly elevated risk of all-cause mortality (adjusted hazard ratio, AHR=1.79; 95% CI: 1.12-2.97). These associations remained statistically significant even after excluding deaths within the first two years of follow-up. From this study, it can be concluded that daily smoking is strongly associated with a significantly higher risk of all-cause mortality (K. H. Lim et al. 2022).

1.2 Cardiovascular Disease Risk among Military Personnel

Cardiovascular disease (CVD) remains a significant public health challenge globally, affecting diverse populations, including military personnel. The unique lifestyle and occupational stressors experienced by military personnel, such as high levels of physical and psychological stress, irregular meal patterns, and potential for tobacco use, elevate their risk for developing CVD. Understanding and mitigating these risk factors are crucial for improving health outcomes within this population.

In the context of military personnel, the risk factors associated with CVD are exacerbated by unique occupational and lifestyle stressors. The unique occupational and lifestyle stressors experienced by military personnel further exacerbate the risk of developing CVD. High levels of physical and psychological stress, irregular meal patterns, and potential tobacco use contribute to an elevated risk of developing CVD within this population. In the United States, a study highlighted that the constant demands of military service negatively impact cardiovascular health, increasing the risk of hypertension, coronary heart disease, and myocardial infarction at younger ages (Hinojosa, 2020). Despite their perceived physical fitness, military personnel are not immune to CVD's insidious threat. Research has increasingly focused on understanding CVD prevalence and management among armed forces personnel, particularly their knowledge of CVD risk factors. For example, a study in Poland assessed the awareness of CVD risk factors among 644 Polish Army soldiers, revealing an overall score of 58.4% correct answers and highlighting the need for enhanced CVD preventive strategies (Olszewski et al. 2009).

However, perception prevention measures, including medication taking and heart-healthy lifestyle, among patients with CVD are often suboptimal (Piepoli et. al 2016). Studies by Gielerak et al. (2019) revealed that CVD risk factors were present in over 50% of Polish soldiers, and exposure to extensive stress and threats in combat conditions was cognized as a specific military-related stressor of additive detrimental effect. Nikolova et al. confirmed that military pilots are exposed to stress factors in the work environment, which affect their autonomic cardiovascular control. CVD risk factors in the active military population correlate with a type of activity in which the degree of stress is extremely high and associated with intense physical exercise, frequently changing climate and time zone conditions, the sense of imminent danger, sleep deprivation, and a frequently unbalanced diet (Maculewicz et al. 2022).

Another study from the Belgian Army revealed a high-risk group of active smokers is found in military personnel younger than 40 years (Mullie et al. 2010). Previous studies have identified actual and potential modifiable barriers to adherence to secondary prevention measures that can be addressed in cardiology clinical practice (Khatib, et al. 2012).

1.3 The Need for Psychometric Evaluation of the Translated CARRF-KL

Despite the critical need for effective CVD prevention and management strategies in the military, there remains a gap in the empirical foundations for classifying knowledge levels regarding CVD risk factors, particularly in non-English-speaking contexts. Addressing this gap, the Cardiovascular Risk Factors Knowledge Level (CARRF-KL) questionnaire serves as a vital tool for assessing individuals' knowledge of CVD risk factors, thereby facilitating tailored patient education and intervention strategies. However, the psychometric properties of the CARRF-KL, especially its ability to distinguish between different levels of knowledge, need rigorous evaluation, particularly in translated versions such as Bahasa Melayu. This study aims to evaluate the psychometric properties of the translated CARRF-KL into Bahasa Melayu, focusing on its ability to distinguish between different levels of respondent knowledge. By conducting this research in a military hospital in Malaysia, we seek to validate the instrument's use in this specific demographic and context. The findings will provide insights into the reliability and validity of the translated CARRF-KL, offering a foundation for its use in educational and clinical settings to enhance CVD prevention strategies among Malaysian military personnel.

2 Method

2.1 Study Design

This study employed a quantitative cross-sectional psychometric design to evaluate the translated Bahasa Melayu version of the CARRF-KL questionnaire among military personnel. The cross-sectional design was appropriate because the purpose was to examine item functioning, person ability, internal structure and measurement precision

at one point in time. Permission to conduct the study was obtained from the Director of Hospital Tuanku Mizan and the Head of the Medical Out-Patient Department prior to data collection. All participants were informed about the study purpose, voluntary participation, and confidentiality of responses. Written informed consent was obtained before questionnaire completion. No personal identifiers were collected, and all data were used solely for research purposes. Data collection was conducted from December 2023 to March 2024 using paper-based questionnaires distributed at the Medical Out-Patient Department of Hospital Tuanku Mizan, Kuala Lumpur. The study included 100 actively serving military personnel who were able to understand Bahasa Melayu and who provided written informed consent.

2.2 Instrument

The Cardiovascular Risk Factors Knowledge Level (CARRF-KL) questionnaire is a validated tool designed to evaluate individuals' understanding of cardiovascular disease (CVD) risk factors. The questionnaire comprises 28 items, categorized into three sections: the first four items focus on general aspects of CVD, 15 items assess knowledge of risk factors, and the remaining nine items explore the outcomes of adopting a risk-free approach (Arikan et al., 2009). The tool uses a simple response format where participants indicate their answers as "Yes," "No," or "Don't know," based on true/false statements.

To ensure a nuanced evaluation, six statements are reverse-scored to minimize response bias. Each correct response is awarded one point, while incorrect answers or "Don't know" responses are scored as zero. The total score is calculated by summing the number of correct responses, dividing by 28, and multiplying by 100 to yield a percentage score. The scoring system classifies participants' knowledge into three categories: scores below 50% indicate 'poor' knowledge, scores between 51% and 70% reflect 'moderate' knowledge, and scores above 70% represent 'good' knowledge.

The translated Bahasa Melayu version of the CARRF-KL questionnaire was used in this study to ensure it aligns with the knowledge level and comprehension of the Malaysian army community, making it culturally and linguistically appropriate for this specific population. The translation underwent validation by experts, including a cardiologist and an anesthesiologist, to ensure its accuracy and relevance.

2.3 Rasch Data Analysis

The Rasch Measurement Model was used to examine the psychometric performance of the translated CARRF-KL. The dichotomous Rasch model was appropriate because each item was scored as correct or incorrect. The analysis was conducted using WINSTEPS version 4.8.1.0. Rasch analysis estimates item difficulty and person ability on a common logit scale, allowing the researcher to determine whether the items form a meaningful hierarchy of difficulty and whether the instrument can distinguish respondents with different levels of CVD risk-factor knowledge.

Several Rasch indicators were used. First, item and person fit were examined using infit and outfit mean-square statistics (MNSQ), supported by standardized Z values (ZSTD). MNSQ values between 0.50 and 1.50 were considered productive for measurement, while ZSTD values beyond approximately +/-2.0 were interpreted as supporting evidence of potential misfit. Second, person separation and person reliability were used to evaluate the extent to which the instrument could distinguish respondents into different ability strata. Third, item separation and item reliability were used to evaluate whether the sample was sufficient to confirm the hierarchy of item difficulty. Fourth, the Wright map was inspected to assess targeting between respondent ability and item difficulty. Finally, principal component analysis of standardized residuals was used to examine dimensionality after the Rasch dimension had been extracted. Variance explained by the Rasch measures and the eigenvalues of unexplained contrasts were reviewed; residual contrasts above approximately 2.0 eigenvalue units were interpreted as requiring substantive review of item clustering or possible secondary dimensions.

3 Results

The study involved 100 participants, with an average age of 34.6 years (SD = 5.15), indicating a predominantly older sample as 72% were over 41 years old. The gender distribution showed a significant male predominance, with 88% male and only 12% female participants, which reflects the typical workforce composition in military settings. In terms of education, most participants (84%) had completed their Malaysian Certificate of Education (SPM), while 13% held diplomas and only 3% had degrees, indicating a generally lower level of formal education. The majority of the participants were married (94%), which may influence their health behaviors and responsibilities. Regarding service categories, 75% of participants were from the infantry, a group associated with physically demanding roles, while 25% were support staff, who may have different occupational health risks. This demographic profile highlights a predominantly older, male, married, and infantry-dominant population with varied educational backgrounds as shown in Table 1.

Table 1. Demographic characteristics of the respondents

Demographic data	N=100	%	Mean (SD)
Age			34.6 (5.15)
20-30	18	18.0%	
31-40	10	10.0%	
>41	72	72.0%	
Gender			
Female	12	12.0%	
Male	88	88.0%	
Education level			
SPM (high school certificate)	84	84.0%	
Diploma	13	13.0%	
Degree	3	3.0%	
Marital status			
Married	94	94.0%	
Single	6	6.0%	
Service category			
Infantry	75	75.0%	
Support staff	25	25.0%	

The item analysis of the CARRF-KL questionnaire indicates varying difficulty levels across its items as shown in Figure 1. KL01 and KL17 emerged as the hardest questions, with only 21% of participants answering them correctly, followed by KL12, KL13, and KL22, with correct response rates between 27% and 34%. In contrast, KL05 was the easiest item, achieving 84% correct responses. Other relatively easier items included KL15, KL06, KL10, and KL19, with correct response rates exceeding 75%. These findings highlight a wide range of item difficulties, suggesting that the questionnaire effectively assesses knowledge at varying levels but may require refinement for optimal balance.

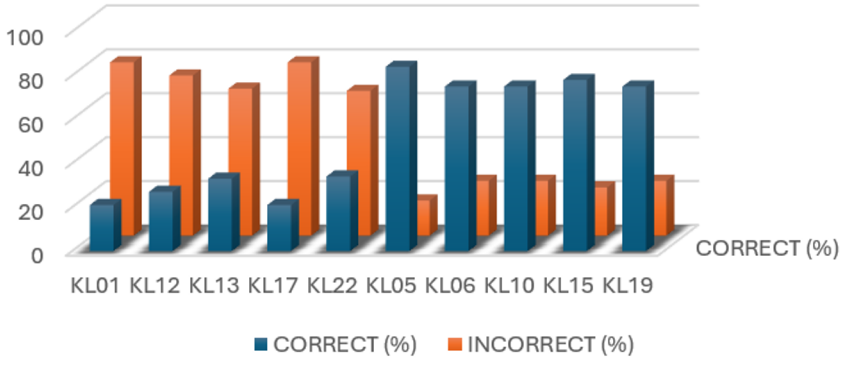


Fig.1. The item analysis of the translated CARRF-KL questionnaire.

The Rasch summary statistics are presented in Table 2. The person separation index was 1.47, with a person reliability of 0.68. These values indicate that the translated CARRF-KL had limited ability to distinguish respondents into clearly separated levels of cardiovascular disease risk-factor knowledge. In contrast, the item separation index was 3.56, with an item reliability of 0.93, suggesting that the item difficulty hierarchy was stable and that the items varied meaningfully in difficulty. The mean outfit MNSQ values for both persons and items were close to 1.00, indicating acceptable overall fit to the Rasch model. However, the Cronbach's alpha value of 0.667 suggests marginal internal consistency. Overall, the findings indicate that although the items demonstrated a stable difficulty structure, further refinement is required to improve the instrument's ability to discriminate between respondents with different knowledge levels.

Table 2. Statistical summary based on Rasch Parameters

	Person	Item
N	100	28
Mean	16.1	57.5
Mean Measure	0.38	0.00
Mean-Outfit ZSTD	-0.03	-0.09
Mean-Outfit MNSQ	1.01	1.01
Separation	1.47	3.56
Reliability	0.68	0.93
Cronbach's Alpha	0.667	

Person-fit diagnostics identified several respondents with atypical response patterns as shown in Table 3, The most prominent example was Participant 98, who had an infit MNSQ of 1.87 and outfit MNSQ of 2.16, with infit ZSTD of 3.89 and outfit ZSTD of 3.90. These values exceed the expected range and indicate that the respondent's pattern of correct and incorrect answers did not conform well to Rasch model expectations. Participant 91 also showed misfit, with infit MNSQ of 1.48 and outfit MNSQ of 1.98, while Participant 11 showed outfit MNSQ of 1.82. These response patterns may reflect guessing, misunderstanding of selected items, careless responding, or genuine unevenness in knowledge across CVD risk-factor domains. Because the purpose of this study was exploratory psychometric evaluation, these cases were reviewed diagnostically rather than automatically removed from the analysis as shown in Figure 2.

Table 3. Person-fit diagnostic example from WINSTEPS outfit

Person	Total score	Measure	Infit MNSQ	Infit ZSTD	Outfit MNSQ	Outfit ZSTD
P98	18/28	0.67	1.87	3.89	2.16	3.90
P91	22/28	1.50	1.48	1.64	1.98	2.04
P11	23/28	1.76	1.20	0.73	1.82	1.56
P70	25/28	2.41	1.04	0.24	1.77	1.13
P97	15/28	0.15	1.60	3.41	1.75	3.51
P94	17/28	0.49	1.63	3.21	1.73	3.01

At the item level, KL01 and KL17 were flagged for review because they were among the most difficult items and may require further examination of wording, translation equivalence and conceptual clarity. The Wright map also suggested that some items clustered around similar difficulty levels, while fewer items targeted respondents with higher CVD knowledge. Future refinement should therefore include cognitive debriefing with military personnel, expert review of difficult and potentially redundant items, and the development of additional higher-difficulty items to reduce ceiling effects and improve person separation.

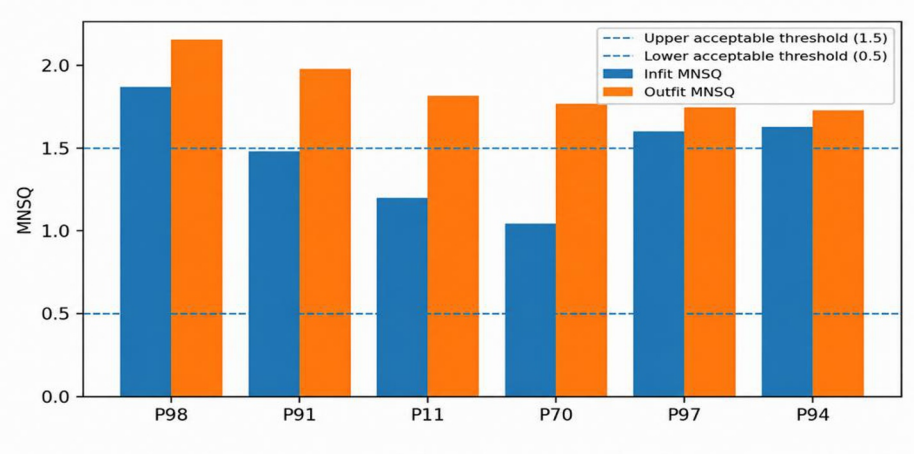


Fig.2. Person-fit diagnostics for selected atypical response patterns.

The dimensionality analysis showed that the Rasch measures explained 22.4% of the observed variance (Table 4). Although this indicates that a measurable primary dimension was present, the strength of the dimension was modest. The first unexplained contrast had an eigenvalue of 3.33 and accounted for 9.2% of the unexplained variance, while the second contrast had an eigenvalue of 2.21. These findings suggest that some item clusters may be contributing additional residual structure after the primary Rasch dimension has been extracted. However, the results do not by themselves confirm a

clearly interpretable second dimension; instead, they indicate that item content should be reviewed to strengthen the coherence of the primary construct.

Table 4. Dimensional analysis of standardized residuals

Component	Eigenvalue	Observed variance	Interpretation
Raw variance explained by measures	8.08	22.4%	Primary Rasch dimension present but modest
Raw variance explained by persons	2.57	7.1%	Limited person differentiation
Raw variance explained by items	5.52	15.3%	Item hierarchy contributes more strongly than person spread
Unexplained variance in 1st contrast	3.33	9.2%	Requires substantive review
Unexplained variance in 2nd contrast	2.21	6.1%	Requires substantive review
Unexplained variance in 3rd contrast	1.97	5.5%	Borderline / monitor

Figure 3 indicates that the Rasch measure dominated the residual structure; however, the first and second contrasts exceeded the 2.0 eigenvalue threshold, suggesting possible secondary dimensions requiring further item-content review and refinement.

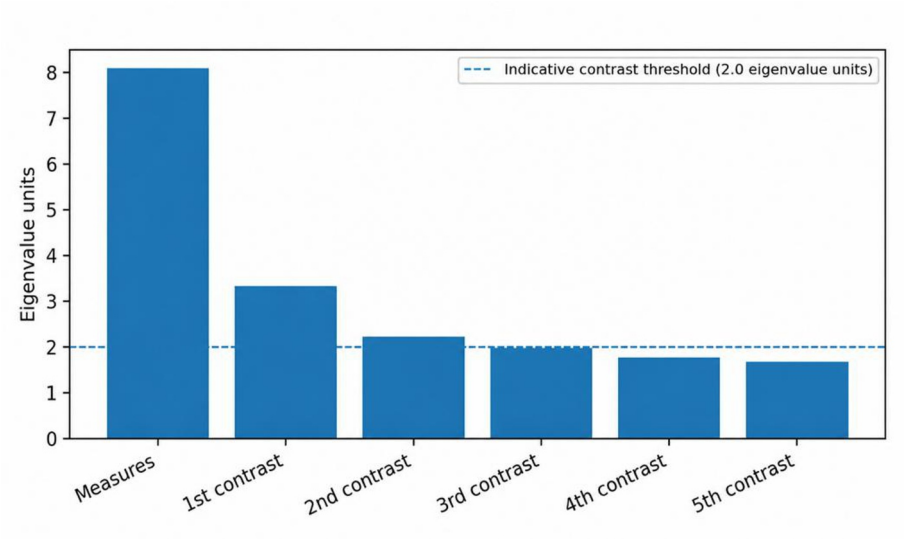


Fig.3. Dimensionality evidence from Rasch residual analysis.

The Wright map in Figure 4 showed that person ability ranged approximately from -1.5 to 4 logits, whereas item difficulty ranged from about -1.5 to 2 logits. This indicates that the translated CARRF-KL was better targeted to respondents with low to average knowledge levels but less effective in measuring respondents with higher ability. The absence of more difficult items above 2 logits suggests a potential ceiling effect, where high-ability respondents may not be sufficiently challenged. Several items were clustered around the 0 to 1 logit range, indicating a concentration of medium-difficulty items. In addition, item clusters such as KL04, KL07, and KL18 may require further review for possible redundancy. Overall, the Wright map suggests that future refinement should include more difficult items and review overlapping items to improve targeting, measurement precision, and discrimination across the full range of respondent knowledge

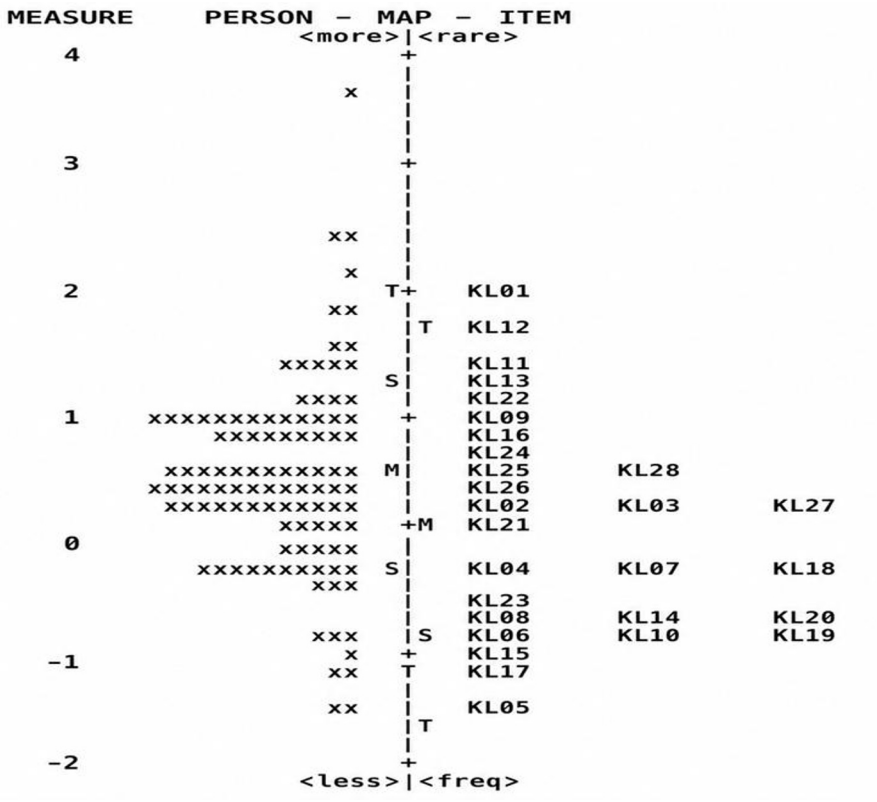


Fig.4. The Wright map of person ability and item difficulty for the translated CARRF-KL.

4 Discussion

The revised Rasch interpretation provides a clearer diagnostic message. The translated CARRF-KL demonstrated strong item reliability and separation, suggesting that the items could be ordered along a meaningful difficulty continuum. However, person reliability and separation were lower, indicating that the current 28-item version did not reliably distinguish respondents into clearly different knowledge strata. This finding is important because Rasch analysis is not only used to estimate reliability, but also to diagnose how well items and persons function along the same measurement continuum (Boone et al. 2017). Therefore, the instrument may be useful for identifying general areas of weak CVD risk-factor knowledge, but it should not yet be used as a definitive tool to classify individual military personnel into precise levels of knowledge.

The person-fit analysis further illustrates the diagnostic value of Rasch methodology. Participant 98, for example, produced a response pattern that was not consistent with model expectations. Such a pattern may occur when a respondent answers easy items incorrectly but difficult items correctly, or when guessing, misunderstanding, or disengagement affects responses. Similar issues have been highlighted in psychometric studies, where respondent motivation, comprehension, and response consistency may influence Rasch fit statistics (Lin et al. 2019). In the context of military healthcare, atypical response patterns may also reflect uneven exposure to health education, variation in literacy, or selective familiarity with certain CVD topics. Therefore, misfitting persons were interpreted as useful diagnostic signals rather than simple data errors.

At the item level, KL01 and KL17 were flagged for review because they were among the most difficult items and may require further examination of wording, translation equivalence, and conceptual clarity. In Rasch analysis, misfitting or overly difficult items may threaten measurement precision and weaken the interpretation of the intended construct if they do not function consistently with the model expectations (Boone et al. 2017). In addition, the Wright map suggested that some items clustered around similar difficulty levels, while fewer items targeted respondents with higher CVD knowledge. Item clustering may indicate potential redundancy or local dependency, which can affect the independence of items and distort the interpretation of reliability and validity (Christensen et al. 2017; Gómez-Benito et al. 2020). Future refinement should therefore include cognitive debriefing with military personnel, expert review of difficult and potentially redundant items, and the development of additional higher-difficulty items to reduce ceiling effects and improve person separation. This is consistent with the recommendation that instruments with ceiling effects require more challenging items to improve targeting and measurement precision across higher ability levels (Wright et al. 2021).

5 Implications of the Study for Military Services and Settings

This study highlights the critical role of tailored patient education in improving cardiovascular health outcomes among military personnel. Patient education strategies leveraging tools like the CARRF-KL can foster targeted interventions to enhance awareness and understanding of cardiovascular disease (CVD) risk factors. Military settings, where physical fitness and operational readiness are paramount, benefit significantly from early identification of at-risk individuals. Incorporating CARRF-KL in military healthcare practices aligns with evidence suggesting that health education tailored to specific populations improves engagement and health outcomes (Lozano et al., 2016; Weiner et al., 2019). Interventions designed to increase awareness, and self-efficacy can reduce the prevalence of CVD, thus promoting better long-term health among military members.

Preventing CVD in military populations requires a proactive approach, emphasizing early risk detection and preventative strategies. The structured and culturally adapted content of the CARRF-KL tool provides a foundation for implementing such strategies effectively. Early identification allows for timely interventions, including lifestyle modifications and access to preventative healthcare services, which are proven to mitigate CVD risks (Goff et al., 2016; Bhatnagar et al., 2020). Within the military context, preventative measures not only enhance individual health but also support the operational capability of the force. Developing a culture of prevention can lead to sustained reductions in healthcare costs associated with managing chronic diseases like CVD.

Adapting the CARRF-KL tool to the military setting involves addressing unique occupational and cultural factors. Military service members often operate under physically and mentally demanding conditions, which can exacerbate risk factors for CVD. Customizing the tool's content to reflect these realities ensures relevance and effectiveness, enhancing its applicability in military healthcare systems. Furthermore, fostering organizational change to normalize discussions around health and lifestyle choices can improve overall well-being among military personnel. Research supports the notion that culturally sensitive interventions are more likely to succeed in fostering behavioral change and improving health outcomes (Heaney & Israel, 2018; McCarthy et al., 2022).

Lastly, for the CARRF-KL tool to have a lasting impact, ongoing training for military healthcare providers is essential. Familiarity with the tool’s application ensures accurate assessments and meaningful interactions with patients. Training also empowers providers to deliver effective education and intervention strategies, fostering long-term adherence to CVD prevention measures (Alsaeed et al., 2020; Misra et al., 2023). By integrating such training into military healthcare programs, the tool can be a cornerstone in promoting cardiovascular health and operational readiness within military communities.

6 Conclusion

The translated Bahasa Melayu CARRF-KL demonstrates potential as a tool for assessing cardiovascular disease risk-factor knowledge among military personnel. Rasch analysis showed strong item reliability and a stable hierarchy of item difficulty, but lower person reliability and person separation indicate that the current version has limited precision for differentiating respondents into distinct knowledge levels. Person-fit diagnostics and residual dimensionality findings identified areas requiring refinement, including review of atypical response patterns, difficult items, possible item redundancy and targeting gaps for higher-ability respondents. Further validation using a larger and more diverse military sample is recommended before the instrument is used for formal classification or evaluation of educational intervention outcomes.

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