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Establishing score equivalence of the GDS-30 scale and International Classification of Functioning, Disability and Health range, using Rasch analysis

Bernard Sozański[1,A-D,F], Agnieszka Beata Ćwirlej-Sozańska[2,A-D,F]✉, Anna Wilmowska-Pietruszyńska[3,A,E-F], Renata Spalek[4,A,E-F], Alessandro de Sire[5,A,E-F], Agnieszka Wiśniowska-Szurlej[2,A-B,E-F]

[1] *Institute of Medical Sciences, College of Medical Sciences of the University of Rzeszow, Poland*
[2] *Institute of Health Sciences, College of Medical Sciences of the University of Rzeszow, Poland*
[3] *Faculty of Medicine, Lazarski University, Warsaw, Poland*
[4] *Department of Geriatrics, Neurosciences, Orthopedics, Center for Geriatric Medicine (CEMI), Institute of Internal Medicine and Geriatrics, Catholic University of the Sacred Heart, Italy*
[5] *Physical Medicine and Rehabilitation Unit, Department of Medical and Surgical Sciences, University of Catanzaro "Magna Graecia", Italy*
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Abstract

Introduction and Objective. Depression is a common problem among older adults. The Geriatric Depression Scale (GDS-30) is a recommended tool for assessing the emotional state of the elderly. To-date, there are no data in literature on the description of GDS-30, according to the International Classification of Functioning, Disability and Health (ICF). The aim of the study is to transform the data obtained using the GDS-30 scale into the common scale of the ICF by applying the Rasch measurement theory.

Materials and method. The study was conducted based on the results of 775 measurements made on people aged 65 and over. The Rasch model with the unconstrained Rasch parameter was used for the study.

Results. The GDS-30 scale was transformed into the ICF scale, where 0 points on the ICF scale were assigned to 0 points on the GDS-30 scale, 1 on the ICF scale – 1–4 points on the GDS-30 scale, 2 on the ICF scale – 5–7 on the GDS-30, 3 on the ICF scale, and 8–19 points on the GDS-30, whereas 4 on the ICF scale, 20–30 points on the GDS-30.

Conclusions. Taken together, the results showed that the GDS-30 scale can be reliably transferred to the universal ICF scale for the b152 Emotional functions code. The ability to transfer the results into the universal language of the ICF category provides a coding system for more efficient information management in health systems, allows for data aggregation, and offers the possibility to compare them. It is also invaluable for clinical practice and research, including creating meta-analyses.

Key words

ICF, Rasch analysis, depression, older adults, Geriatric Depression Scale

INTRODUCTION AND OBJECTIVE

Depression is a mood disorder characterized by, among other things, sadness, loss of interest, lower self-esteem, decreased activity, and decline in vitality. It is a very common mental disorder [1, 2, 3] associated with significantly worse functioning and quality of life, as well as higher rates of comorbidity [4, 5]. Depression can also uncharacteristically cause somatic symptoms, such as fatigue or increased pain [6]. Depression co-occurs with somatic chronic diseases and multi-morbidity in the elderly [7], making their treatment more difficult [8]. Depression is the leading cause of disability worldwide and is a major factor that contributes to the overall global burden of disease [9]. Co-occurrence of depression is associated with higher costs of treating chronic diseases [10], and is a main risk factor for disability and mortality in the elderly [11, 12]. People with depressive disorders have a 40% greater chance of premature death than those without depression [13, 14].

The World Health Organization (WHO) estimated that depressive disorders among the elderly worldwide ranged from 10–20% [13]. Zenebe et al. performed a systematic review of the literature and concluded that major depression affected over 30% of the older population [15]. In 2019, the Central Statistical Office in Poland found symptoms of depression among people aged 60–69 in almost 20% of subjects, in 31% among people aged 70–79 and in almost 48% of people aged 80 and over [16].

Depressive disorders with significant intensity in the period before the COVID-19 pandemic accounted for 38.7 million

✉ Address for correspondence: Agnieszka Beata Ćwirlej-Sozańska, Institute of Health Sciences, College of Medical Sciences, University of Rzeszow, Poland
E-mail: asozanska@ur.edu.pl

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total Disability-Adjusted Life Years (DALYs) worldwide, corresponding to 497 DALYs per 100,000 residents. Since the onset of the pandemic they have been responsible for 49.4 million DALYs [16].

The Geriatric Depression Scale (GDS-30) is a commonly recommended screening tool to assess the emotional state of older persons [17] and has high psychometric properties [18]. Nevertheless, there are many tools for assessing depression and emotional state [19, 20]. Gathering information using different tools does not allow for comparisons and also makes it difficult to aggregate them in the health care IT system [21]. Therefore, it is important to establish a unified, standard language to collect data on the functioning and health experiences of older people. The answer to these needs is the International Classification of Functioning, Disability and Health (ICF) developed by the WHO [22], which contains a set of codes describing the functions and structures of the human body, activity, and participation, as well as environmental factors. The level of human functioning is a key indicator describing the effect of a health intervention [23]. In order to be able to aggregate the unified data, it is necessary to introduce a system for transforming the measurement results into a neutral common scale based on ICF, such as the ICF Generic-30 Set [24].

The Rasch analysis is one of the most detailed studies of the parameters of the items and properties of the scale and might estimate accurately the capability of the scale to differentiate individual levels of depression [25]. The Rasch analysis estimates the relative contribution of each test item to the final diagnosis expressed as the item difficulty. The Rasch model is identical to the one-parameter model of the Item Response Theory (IRT) [26]. This is a probabilistic, one-dimensional measurement model assuming that the response to a specific item is a function of two parameters: the severity of the tested trait in the subject and the item difficulty, whereby these parameters are independently estimated using the same measure [27]. Using the Rasch model, it becomes possible to transform the raw scores into a variable determined on the interval scale [25].

Currently, ICF is implemented in Poland in health information systems. It is necessary to integrate information on functioning by means of ICF with national health information systems [28, 29]. Therefore, the aim of this study was establishing score equivalence of the GDS-30 scale, and the ICF scale for the category b152 Emotional functions, using the Rasch analysis. This study is the first example of converting and adjusting the results obtained by a commonly used measurement tool to the universal ICF classification system in Poland.

MATERIALS AND METHOD

Study design. The results for the analysis were obtained from a cross-sectional study conducted on a representative population of people aged 65 and over living in south-eastern Poland.

Setting and participants. Implementation and popularization of ICF in Poland is carried out by the e-Health Centre in Warsaw. The Council for the International Classification of Functioning, Disability and Health, appointed by the Director of the e-Centre, coordinates work-related to the implementation of the ICF in Poland. Council members carry out scientific projects aimed at assessing the use of ICF and tools based on it in cross-sectional research and clinical practice in Poland. Mapping tools to the ICF category is one of the projects focused on unification of reporting in healthcare IT systems.

To solve the problem of the comparability of information obtained from various tools, an algorithm for transforming the score range of a measuring tool on the ICF scale has been developed. In order to create and validate the transformation algorithm, the GDS tool has been selected.

The validation sample included the results of a study of 775 older people living the Sub-Carpathian Province (Podkarpackie Voivodeship) in south-eastern Poland, inhabited by 439,000 people of post-working age [30]. Calculation of the sample size was based on the following assumptions: 95% (0.95) confidence level, fraction size meeting the inclusion criteria equals 0.5, and a maximum estimation error of 4%. It was assumed that the total planned number of subjects should be n = 800. After checking the completeness of the collected data, 775 people were included in the analysis.

The survey was conducted using the Random Route method among people aged 65 and over living in south-eastern Poland. The subjects were selected by the multi-stage cluster sampling method to ensure a representative sample in terms of the region of residence and the size of the town. The sampling was carried out using the SPSS programme.

The inclusion criteria for the study were: age 65 and over, normal cognitive state – the Abbreviated Mental Test Score (AMTS > 6 points), and informed consent to participate in the study. The exclusion criteria were: cognitive impairment (AMTS ≤ 6 points), and the lack of informed consent to participate in the study.

Ethics approval. The study design was approved by the Bioethical Committee of the University of Rzeszów (Resolution No. 9/12/2019). In accordance with the Helsinki Declaration, the participants were provided with information about the purpose and course of the study. They provided written consent to participate in the study, and were informed about the possibility of withdrawing from the study at any stage.

Data Collection. A shortened version of the AMTS questionnaire was used to assess the participants' cognitive status [31]. The interview was conducted directly with the elderly with the questionnaire serving as a screening criterion (AMTS > 6 points) to ensure that reliable answers were collected. Additionally, information was collected on socio-economic variables such as age, gender, place of residence, marital status, education, income, health and functioning.

The commonly-recommended 30-point Geriatric Depression Scale (GDS-30) was chosen to assess the emotional state of older adults [32]. The Polish version of the GDS questionnaire is an accurate and reliable screening tool for assessing the occurrence and severity of depression in older people [33].

The full version of the GDS consists of 30 questions to which the respondent answers by means of a dichotomous scale: 'Yes' or 'No'. Assessment of the answers is made according to a key in which 1 point is given for the answer confirming the participant's lowered mood. The more points, the higher

the risk of depression symptoms in the subject. The general interpretation of the results is carried out according to the following scale: 0–9 points = no depression, 10–19 points = mild depression, 20 and more points = severe depression [17]. As it does not have a simple reference to the ICF category, it was neecessary to develop a different interpretative scale.

The ICF code b152 Emotional functions was linked with the GDS according to the ICF Linking Rules WHO [34]. A scale indicating the severity of the health problem was linked to the description of the code in accordance with the ICF applying rules:

xxx.**0** – NO problem [0–5%)
xxx.**1** – MILD problem [5–25%)
xxx.**2** – MODERATE problem [25–50%)
xxx.**3** – SEVERE problem [50–96%)
xxx.**4** – COMPLETE problem [96–100%]
xxx.**8** – not specified
xxx.**9** – not applicable.

Statistical methods. The Rasch model with the unconstrained Rasch model was used for the analysis, which proved to be a significantly better fitted for the data than the classic Rasch model. The discrimination parameter for this model was 1.18, while its value for the classical model was 1.00. The analysis was carried out in the R program, version 4.0.3 with the ltm package [35].

RESULTS

Table 1. Characteristics of the study group (N = 775)

Variables	
Age [years] [mean (SD)]	74.1 (7.3)
Gender [n (%)]	
Female	526 (67.87)
Male	249 (32.13)
Education [n (%)]	
Primary or incomplete primary	218 (28.13)
Vocational	198 (25.54)
Secondary	273 (35.23)
Higher	86 (11.10)
Place of residence [n (%)]	
Urban (City/Town)	360 (46.45)
Rural	415 (53.55)

526 women and 249 men participated in the study. The mean age of the subjects was 73.3 (7.8) years. Most subjects had secondary education (273; 35.23%) and lived in rural areas (415; 53.55%)

The value 'z', calculated from the Rasch model, indicates the severity of the studied trait (depression) in the respondent, while 'SE (z)' is the standard error of this value. The value of 'Normal CDF (z)' determines the percentage of subjects who obtained a given or lower GDS 30 raw score, predicted by the Rasch model. This percentage can therefore be interpreted as the severity of symptoms of depression, and directly transformed into the ICF level, according to the principle that the results in the range [0–5%) of symptom severity is level 0, [5–25%) is level 1, [25–50%) is level 2, [50–95%) is level 3, and [95–100%] is level 4.

Table 2. GDS raw score (30 points) transformations into levels defined by ICF

GDS 30 points	z	SE(z)	Normal CDF(z)	ICF level
0	-1.892	0.596	0.029	0
1	-1.516	0.538	0.065	1
2	-1.203	0.495	0.114	1
3	-0.935	0.461	0.175	1
4	-0.700	0.434	0.242	1
5	-0.490	0.413	0.312	2
6	-0.297	0.396	0.383	2
7	-0.120	0.382	0.452	2
8	0.046	0.370	0.518	3
9	0.203	0.361	0.580	3
10	0.353	0.353	0.638	3
11	0.496	0.346	0.690	3
12	0.635	0.341	0.737	3
13	0.770	0.338	0.779	3
14	0.903	0.335	0.817	3
15	1.034	0.333	0.849	3
16	1.164	0.332	0.878	3
17	1.293	0.332	0.902	3
18	1.423	0.333	0.923	3
19	1.554	0.335	0.940	3
20	1.687	0.338	0.954	4
21	1.823	0.342	0.966	4
22	1.962	0.347	0.975	4
23	2.107	0.354	0.982	4
24	2.257	0.362	0.988	4
25	2.416	0.373	0.992	4
26	2.584	0.385	0.995	4
27	2.766	0.401	0.997	4
28	2.964	0.421	0.998	4
29	3.185	0.447	0.999	4
30	3.437	0.481	1.000	4

Table 3 summarizes the norms resulting from the Rasch model for the GDS-30 transformed into the ICF scale.

Table 3. Standards for the transformation of GDS-30 scores into the universal ICF scale

ICF level	Normal CDF(z)	GDS 30 points
0	[0–5%)	0
1	[5–25%)	1–4
2	[25–50%)	5–7
3	[50–95%)	8–19
4	[95–100%]	20–30

The ICF level from 0–2 (0–7 GDS points) fully covers the category of no depression (0–9 GDS points), the IFC level of 3 (8–19 GDS points) covers the mild depression category (10–19 GDS points) to a large extent, while the ICF level of 4 (20–30 GDS points) fully covers the severe depression category (20–30 GDS points).

Analysis of individual items of the GDS questionnaire. Table 4 presents the difficulties of individual test items evaluated in the Rasch model with their standard errors (SE). The items are ranked from the most difficult to the least difficult.

In the Rasch model, the test item is called 'difficult' when most of the respondents with high values of the examined feature choose the diagnostic answer. Therefore, in the case of the GDS scale, the item 'difficult' will be the item in which the diagnostic response is chosen mainly by subjects with high severity of depression.

A characteristic feature of the Rasch model is the fact that the ratings of the difficulty of individual test items are expressed on the same scale as the ratings of the severity of the examined feature (here: the level of depression) in the respondents (i.e. 'z' in Table 2). As a result, the difficulty of a given item can be interpreted as the severity of the studied trait, at which choosing the diagnostic response becomes more likely than not choosing it.

The most difficult was position 15 (Question: 'Is it wonderful to be alive?'). Its difficulty is 2,767, which corresponds to approximately 27 points on the GDS raw scale and 4th ICF level (see Table 1). This means that only in patients with such a strong depression, the percentage of diagnostic answers (i.e., 'No' answers) in this item exceeds 50%.

In turn, the easiest one was item 12 (the question about spending evenings at home). Its difficulty is -1.694 (below 1 point on the GDS raw scale and 0 ICF level); therefore, even among people with such a low level of depression, the percentage of diagnostic answers (i.e., 'Yes' answers) was over 50%.

Table 4. Assessment of the difficulty of individual test items

Item	Difficulty	SE
Item 15	2.762	0.158
Item 19	2.646	0.151
Item 22	2.609	0.149
Item 1	2.591	0.148
Item 3	2.307	0.134
Item 17	2.211	0.129
Item 7	1.946	0.118
Item 9	1.902	0.116
Item 25	1.749	0.110
Item 27	1.617	0.106
Item 16	1.477	0.101
Item 23	1.285	0.096
Item 6	1.225	0.094
Item 14	1.173	0.093
Item 5	1.159	0.093
Item 28	1.080	0.091
Item 10	1.052	0.090
Item 18	0.984	0.089
Item 26	0.957	0.088
Item 4	0.917	0.087
Item 29	0.917	0.087
Item 24	0.858	0.086
Item 11	0.813	0.085
Item 13	0.304	0.079
Item 21	0.173	0.078
Item 8	-0.124	0.078
Item 20	-0.141	0.078
Item 30	-0.373	0.079
Item 2	-0.511	0.081
Item 12	-1.694	0.107

DISCUSSION

The ICF approach, which is a global standard for describing functioning, health and disability information, serves as a neutral and conceptual reference for comparing the content of different tools by means of transformations to a combined metric. On the other hand, Rasch analysis used in medical research allows for the creation of a scoring and transformation table based on intervals which can assist in the calculation of correct scores regarding functioning and functional changes [36, 37].

The presented study provides an ICF-based metric for the GDS-30 scale, which facilitates a standardized evaluation and reporting system providing information on emotional functioning. The GDS scale was substantively linked by the research team with the ICF code b152 Emotional functions. The study provides an example of how the GDS-30 scale can be transformed into an ICF scale with reference to a selected category. The methodology employed in the study can form the basis of further research in which conceptually similar information regarding functioning is gathered using different tools, and can be compared and aggregated using the universal ICF scale. With the common measure based on the ICF, other tools assessing functioning can be added [21]. Any number of instruments may be included in a common measure if they are conceptually equivalent.

There are several functional assessment tools available in the literature that have been linked to ICF codes. These are the Barthel Index (BI) for assessing activities of daily living, scales for assessing basic and instrumental activities of daily living (ADL and IADL) and the Functional Independence Measure (FIM). The FIM scale examines two main aspects of functioning consisting of motor and cognitive subscales, while the BI and ADL and IADL include an assessment of the motor area. The individual components of the scales are combined with ICF activity and participation codes [38]. The ICF classification provides the ability to analyse a broad spectrum of patient functioning, both in the cognitive, motor, social, and environmental domains [39]. It is possible to link most of the test items identified by commonly used functional assessment tools to specific categories of the ICF classification [40, 41].

Preparation of ready-made transformations of commonly used diagnostic assessment tools transformed into the universal ICF scale will significantly facilitate the uniform coding of health information, as well as the development of computer systems. It will also simplify the implementation of the ICF classification. Due to the calculations made by scientists, clinicians can still use the diagnostic tools used so far, and computer systems can recode and aggregate data on the health and functioning of patients.

Since ICF is a universal language, and different measurement and clinical tools are used in different places

worldwide, to reliably transform the obtained result into the ICF scale, so that it is comparable, it is extremely important to use appropriate methods of converting the scales used in practice into the ICF scale. Rasch's analysis fulfills these conditions. It is a method recommended in research and rehabilitation which can be used as a measurement model, and on its basis it is able to adjust the scale of the used measurement tools [42].

Combining the measurement results with the ICF makes it possible to compare the content of any compared scales. The Rasch measurement model determines *a priori* requirements that are in line with the primary measurement [43]; thus, once the data meets the model's expectations, the interval scale metric results can be used to create exchange results as well as monitor the performance of individuals and populations in time [44]. The Rasch model converts the results into an interval scale, which can be compared with any other scale with a given percentage distribution, such as the ICF scale. The ICF scale determines what percentage of patients should be in each of its levels.

CONCLUSIONS

Taken together, the findings of the present study show that the GDS-30 scores might be reliably transferred to the universal ICF scale. The integration of the ICF linking rules and the Rasch measurement model is used as the methodological basis for this purpose. The possibility of translating the results into the code language provides a coding system for more efficient information management in healthcare systems, allows for the data aggregation and offers the possibility of comparing them at the national or international level. This is crucial in planning activities and making systemic decisions regarding medical care or social care. The capability to compare directly and consistently the results obtained on different scales is also extremely valuable for both clinical practice and research, including the creation of meta-analyses.

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