

Tool for Calculating Quality of Life Scores Assessed by the SF-12 Scale

Ferramenta para Calcular os Escores da Qualidade de Vida Avaliada pela Escala SF-12

Herramienta para el Cálculo de Puntajes de Calidad de Vida Evaluados por la Escala SF-12

RESUMO

Objetivo: Esse estudo objetivou apresentar e disponibilizar uma ferramenta, intitulada CalcSF-12, para o cálculo dos escores e estatística descritiva dos componentes físico (PCS) e mental (MCS) do instrumento de avaliação da qualidade de vida 12-item health survey (SF-12). **Método:** Para implementação do sistema da CalcSF-12 adotou-se tecnologias de desenvolvimento como APIs (applications protocol interface), frameworks, extensões e bibliotecas. A CalcSF-12 é de fácil manuseio, prática e não exige dos usuários conhecimentos avançados em estatística. Para utilizá-la, o pesquisador necessita apenas entrar com os dados, digitando-os ou exportando-os do Excel, e os cálculos serão realizados automaticamente. **Resultado:** a CalcSF-12 apresentou concordância de 100% quando seus resultados foram comparados com aqueles obtidos pelo software SPSS. **Conclusão:** conclui-se que a ferramenta criada é fidedigna para os cálculos dos escores e estatística descritiva dos componentes PCS e MCS do instrumento SF-12.

DESCRIPTORES: Tecnologia e desenvolvimento; Qualidade de vida; Estatística; Saúde Coletiva.

ABSTRACT

Objective: this study aimed to present and make available a tool, entitled CalcSF-12, for the calculation of scores and descriptive statistics of the physical (PCS) and mental (MCS) components of the assessment instrument of quality of life 12-item health survey (SF-12). **Method:** to implement the CalcSF-12 system, development Technologies were adopted such as APIs (applications protocol interface), frameworks, extensions and libraries. The CalcSF-12 it is easy to use, practical and does not require advanced knowledge in statistics from users. To use it, the researcher only needs to enter the data, typing them or exporting them from Excel, and the calculations will be performed automatically. **Results:** the CalcSF-12 showed 100% agreement when its results were compared with those obtained by the SPSS software. **Conclusion:** it is concluded that the tool created is reliable for the calculation of scores and descriptive statistics of the PCS and MCS components of the SF-12 instrument.

DESCRIPTORS: Technology and development; Quality of life; Statistics; Collective Health.

RESUMEN

Objetivo: Presentar y poner a disposición la herramienta CalcSF-12 para el cálculo de los puntajes y de la estadística descriptiva de los componentes físico (PCS) y mental (MCS) del 12-Item Health Survey (SF-12). **Método:** Para implementar CalcSF-12 se utilizaron tecnologías como APIs, frameworks, extensiones y bibliotecas. La herramienta es de fácil manejo, práctica y no requiere conocimientos avanzados en estadística. El investigador solo necesita ingresar los datos, digitándolos o exportándolos desde Excel, y los cálculos se realizan automáticamente. **Resultados:** CalcSF-12 presentó una concordancia del 100% al comparar sus resultados con los obtenidos mediante el software SPSS. **Conclusión:** La herramienta desarrollada es fidedigna para el cálculo de los puntajes y de la estadística descriptiva de los componentes PCS y MCS del SF-12.

DESCRIPTORES: Tecnología y desarrollo; Calidad de vida; Estadística; Salud Colectiva.

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INTRODUCTION

Quality of Life (QoL) is a subjective and multidimensional construct that has been defined by the World Health Organization's QoL group as "an individual's perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns." Concern for the individual as a whole, and not just in terms of disease, has led to increased interest in measuring health-related quality of life (HRQoL). There is evidence that this term first appeared in medical literature in the 1930s². Since the 1970s, several instruments have been developed with the aim of codifying individuals' subjective perceptions of QoL through objective data, facilitating their interpretation in health research³.

These instruments can be specific, assessing the impact of a particular disease on an individual's HRQoL, such as: OHIP-14⁴, PDQ-39⁵, WHO-QOL-HIV⁶ and DQOL-Brasil⁷, developed to assess the impact of oral health, Parkinson's disease, HIV-AIDS, and diabetes on individuals' QoL, respectively. On the other hand, there are generic instruments that assess an individual's QoL in general, such as WHO-QOL-BREF⁸, KIDSCREEN-27⁽⁹⁾ and

SF12¹⁰.

Among the generic instruments, the *12-item health survey (SF-12)* stands out, which has been widely used in QoL assessment studies^{11,12,13}. The SF-12 was adopted in a study of adolescents in a municipality in the northern state of Minas Gerais, and after the publication of the articles resulting from this study, entitled "Psychometric properties of the quality of life assessment instrument: 12-item health survey (SF-12)"³ and "Quality of life among adolescents: a cross-sectional study using the SF-12"¹⁴, numerous requests were received from researchers asking for guidance on the algorithm for calculating QoL scores measured by the SF-12 instrument.

Given such high demand, it was found that there was no tool available for researchers who need to obtain SF-12 scores when applied to a sample with several individuals. The few technological tools available only provide the results of an individual form to be filled out by the user. In this sense, with a view to filling this gap, the present study aims to construct a tool for calculating QoL scores assessed by the SF-12.

METHOD

The study was based on the *12-Item Short-Form Health Survey - SF-12*¹⁰ questionnaire, created in 1994

by Ware *et al.* as a faster alternative to the *36-Item Health Survey (SF-36)*¹⁵ instrument, previously developed by the same authors. The national and international literature describes several studies conducted over the years that have demonstrated the validity of the SF-12^{16, 17, 18, 19, 20}.

The SF-12 consists of twelve items (Table 1) that consider the individual's perception of aspects of their health in the four weeks prior to the application of the instrument¹⁰. Each item of the SF-12 has a group of responses distributed on a Likert-type scale, with the following dimensions being assessed: general health, functional capacity, physical aspect, emotional aspect, pain, mental health, vitality, and social aspect.

Using the instrument's own algorithm, two components of QoL can be measured: physical (PCS) and mental (MCS). According to the authors, the questions that assess general health, functional capacity, physical appearance, and pain are more closely correlated with the physical component, while vitality, social function, emotional appearance, and mental health are more closely correlated with the mental component. In both cases, the score ranges from zero to one hundred, with higher scores associated with better QoL levels²¹.

Quadro 1. Questionário 12-Item Short-Form Health Survey (SF-12)

Dimensions	Items
Health overall	SF1: Overall, would you say your health is: (1) Excellent (2) Very good (3) Good (4) Fair (5) Poor.
Functional capacity	The following items are about activities you could currently do during a typical day. Because of your health, would you have difficulty doing these activities? SF2: Moderate activities, such as moving a table, vacuuming, playing ball, sweeping the house. (1) Yes. It is very difficult (2) Yes. It is somewhat difficult (3) No. It is not difficult at all. SF3: Climbing several flights of stairs (1) Yes. It is very difficult (2) Yes. It is somewhat difficult (3) No. It is not difficult at all.
Physical appearance	During the last four weeks, have you had any of the following problems with your work or regular daily activities as a result of your physical health? SF4: Have you done less than you would like? (1) Yes (2) No SF5: Were you limited in your type of work or other activities? (1) Yes (2) No
Emotional aspect	During the last four weeks, have you had any of the following problems with your work or regular daily activities as a result of emotional problems (such as feeling depressed or anxious)? SF 6: Did you accomplish less than you would have liked? (1) Yes (2) No SF7: Did you work or do any activities with as much care as you usually do? (1) Yes (2) No
Pain	SF8: During the past four weeks, how much has pain interfered with your normal work (including both work outside the home and work inside the home)? (1) Not at all (2) A little (3) Moderately (4) Quite a lot (5) Extremely
Mental Health and Vitality	The following questions are about how you have been feeling and how things have been going for you over the past four weeks. SF 9: How often have you felt calm or peaceful: (1) All the time (2) Most of the time (3) A good part of the time (4) Some of the time (5) A small part of the time (6) Not at all SF10: How much of the time have you felt very energetic? (1) All the time (2) Most of the time (3) A good part of the time (4) Some of the time (5) A small part of the time (6) Not at all SF11: How much time have you felt discouraged and depressed? (1) All the time (2) Most of the time (3) A good part of the time (4) Some of the time (5) A small part of the time (6) Not at all
Aspect social	SF12: During the last four weeks, how much of your time has your health or emotional problems interfered with your social activities, such as visiting friends, relatives, going out, etc.? (1) All the time (2) Most of the time (3) Sometimes (4) A little of the time (5) None of the time

The algorithm for calculating the PCS and MCS scores of the SF-12 involves two main steps. Initially, spe-

cific weights are assigned to each response of the twelve items of the SF-12, both for the physical domain and

for the mental domain, as described in Table 2.

Table 2: Weight values assigned to responses to SF-12 items

ITEM	WEIGHT						
SF1	PCS1	1=0	2=-1.31872	3= -3.0296	4=-5.56461	5=-8.37399	
	MCS1	1=0	2=-0.06064	3= 0.03482	4=-0.16891	5=-1.71175	
SF2	PCS1	1=-7.23216	2=-3.45555	3=0			
	MCS1	1= 3.93115	2= 1.86840	3=0			
SF3	PCS1	1=-6.24397	2=-2.73557	3=0			
	MCS1	1=2.68282	2=1.43103	3=0			

SF4	PCS1	1=-4.61617	2=0				
	MCS1	1=1.44060	2=0				
SF5	PCS1	1=-5.51747	2=0				
	MCS1	1=1.66968	2=0				
SF6	PCS1	1=3.04365	2=0				
	MCS1	1=-6.82672	2=0				
SF7	PCS1	1=2.32091	2=0				
	MCS1	1=-5.69921	2=0				
SF8	PCS1	1=0	2=-3.80130	3=-6.50522	4=-8.38063	5=-11.25544	
	MCS1	1=0	2=0.90384	3=1.49384	4=1.76691	5=1.48619	
SF9	PCS1	1=0	2=0.66514	3=1.36689	4=2.37241	5=2.90426	6=3.46638
	MCS1	1=0	2=-1.94949	3=-4.09842	4=-6.31121	5=-7.92717	6=-10.19085
SF10	PCS1	1=0	2=-0.42251	3=-1.14387	4=-1.61850	5=-2.02168	6=-2.44706
	MCS1	1=0	2=-0.92057	3=-1.65178	4=-3.29805	5=-4.88962	6=-6.02409
SF11	PCS1	1=4.61446	2=3.41593	3=2.34247	4=1.28044	5=0.41188	6=0
	MCS1	1=-16.15395	2=-10.77911	3=-8.09914	4=-4.59055	5=-1.95934	6=0
SF12	PCS1	1=-0.33682	2=-0.94342	3=-0.18043	4=0.11038	5=0	
	MCS1	1=-6.29724	2=-8.26066	3=-5.63286	4=-3.13896	5=0	

Next, the final PCS and MCS scores are obtained by summing the weights assigned to each item and adding a specific constant for each component. The formulas used are:

PCS = PCS1 + PCS2 + PCS3 + PCS4 + PCS5 + PCS6 + PCS7 + PCS8 + PCS9 + PCS10 + PCS11 + PCS12 + 56.57706

MCS = MCS1 + MCS2 + MCS3 + MCS4 + MCS5 + MCS6 + MCS7 + MCS8 + MCS9 + MCS10 + MCS11 + MCS12 + 60.75781

The CalcSF-12 tool was designed as a web-based system for researchers and healthcare professionals. The following development technologies were used to build it: APIs (*application programming interfaces*), *frameworks*, extensions, and libraries. StarUML was used for system modeling and architecture; the code editor platform adopted was the Visual Studio Code integrated development environment. The programming languages used were PHP (*Hypertext Preprocessor*) and *JavaScript*, as well

as HTML (*HyperText Markup Language*) and CSS (*Cascading Style Sheets*), used in the visual layer and system interface, the *Laravel* and *Bootstrap* frameworks, and the *Laravel-Excel* application programming interface.

The CalcSF-12 system was designed with the following features: (1) main module, which presents an overview of the system with a navigation bar, action buttons, calculator area, and summary descriptive statistics area; (2) instructions page, which details how the calculator works, its features and resources, and provides a template file for importing data from Excel; (3) SF-12 description page, which presents conceptual information about the SF-12 questionnaire and the online calculator proposal; (4) calculator interface, which allows manual data entry (rows for individuals, 12 columns for questions SF1 to SF12) with value validation. It supports data import via Excel, with a structured template for filling in; (5) automated calculation of PCS and MCS scores for each individual after

data entry or import; (6) data management, with buttons to "insert new" individual and "delete" data sets; (7) conceptual information with tooltips when hovering over items SF1 to SF12, explaining the dimension and corresponding question; (8) functionality to display descriptive statistics and generate reports in PDF format; (9) export of results that allows exporting the results of the calculated scores.

The reliability of CalcSF-12 was tested by comparing the scores obtained by the tool with those generated by the SPSS statistical software. The validation criterion was the percentage agreement between the results.

RESULTS

The CalcSF-12 tool was successfully developed, offering an intuitive and functional web interface for calculating SF-12 scores, which can be downloaded at <https://calcsf12.ppg-mcs.com.br/>. The system is aimed at researchers and health professionals

and does not require advanced knowledge of statistics for its use.

The general layout of the system features a navigation header, action buttons, and the central area of the calculator. The menu provides access to the home page, instructions, and information about the system. The calculator area allows data to be entered either manually or by importing Excel files, and a structured template for importing is provided. Data validation ensures that the values entered are within the allowed range for each SF-12 item.

After data entry or import, CalcSF-12 automatically calculates the PCS and MCS scores for each individual. The "more options" feature allows you to view descriptive statistics and generate PDF reports, as well as export the calculated scores. To assist the user, information bubbles appear when hovering the mouse over items SF1 to SF12, detailing the dimension and corresponding question.

A comparison of the results obtained by CalcSF-12 with those generated by SPSS software showed 100% agreement. This finding confirms the reliability of the tool for calculating scores and descriptive statistics for the PCS and MCS components of the SF-12 instrument.

DISCUSSION

Quality of life assessment is a fundamental pillar of health research, and the *12-item Short-Form Health Survey (SF-12)* has established itself as an important generic instrument for this purpose. However, as pointed out in the introduction to this study, the complexity inherent in the algorithm for calculating the PCS and MCS scores of the SF-12 has posed a practical challenge for many researchers, especially those who work with large volumes of data or who do not have access to advanced statistical software or programming expertise.

The demand for guidance on the algorithm, mentioned in the article, is clear evidence of this gap.

The CalcSF-12 tool emerges as a direct response to this need, filling an important gap in the availability of resources for QoL research. The main contribution of this work is the provision of a web platform that automates a process that would otherwise be manual, error-prone, and time-consuming. Its ease of use and lack of requirement for advanced statistical knowledge democratize access to SF-12 data analysis, allowing a broader spectrum of professionals and researchers to use the instrument efficiently.

The validation of CalcSF-12, demonstrating 100% agreement with the results obtained by the SPSS software, is an extremely relevant finding. This total agreement gives the tool high reliability, ensuring that the calculated scores are accurate and reliable. In a research context where data integrity is paramount, rigorous validation of computational tools is essential. The specialized literature often emphasizes the importance of validated instruments and analysis methods to ensure the robustness and replicability of studies. For example, studies such as those by Ware et al. (1996) and Damásio et al. (2015) have focused on validating the SF-12 in different contexts, underscoring the need for confidence in measurement instruments. CalcSF-12 extends this confidence to the process of calculating scores.

When comparing CalcSF-12 with other existing solutions, the study highlights that "the few technological tools available only provide the results of an individual form to be filled out by the user." This is a critical point that sets CalcSF-12 apart. While some online calculators may exist for the SF-12, they are generally designed for item-by-item data entry, making it impossible to analyze larger samples.

CalcSF-12's ability to import data from Excel and process multiple individuals simultaneously represents a significant advance in terms of scalability and efficiency. This aligns the tool with the growing trend in health research to use digital solutions to optimize the management and analysis of large databases, as observed in various areas of epidemiology and public health.

The adoption of modern web technologies (PHP, *JavaScript*, *Laravel*, *Bootstrap*) ensures the tool's accessibility via a browser, in addition to facilitating its maintenance and future updates. The ability to generate PDF reports and export score results contributes to the organization and dissemination of research findings.

Despite the obvious advantages, it is important to consider the current scope of the tool. CalcSF-12 is specifically developed for the SF-12. Although the SF-12 is widely used, the existence of other QoL instruments, such as the SF-36, which has more items and dimensions, suggests that future versions could explore the inclusion of other questionnaires. In addition, the tool, in its current description, focuses on PCS and MCS scores and descriptive statistics. The integration of more complex inferential analyses, such as comparisons between subgroups or modeling of associated factors, could further expand its usefulness for researchers seeking more in-depth analyses directly on the platform.

In short, CalcSF-12 solves a practical problem faced by researchers using the SF-12 and contributes to the efficiency and quality of health research. Its validation and user-friendly interface position it as a resource aligned with the evolution of research methodologies that seek to optimize the collection, processing, and analysis of complex data.

CONCLUSION

This study resulted in the development and validation of the CalcSF-12 web tool, designed to calculate the physical (PCS) and mental (MCS) component scores of the *12-item Short-Form Health Survey (SF-12)* instrument, in addition to generating descriptive statistics. CalcSF-12

showed 100% agreement with the results obtained by the SPSS software, confirming its reliability and accuracy. The tool is easy to use, practical, and does not require advanced statistical knowledge from users, allowing manual entry or import of data via Excel for automated calculations. It is

concluded that CalcSF-12 is a robust and reliable solution that fills an important gap in quality of life research, facilitating the processing of SF-12 data for researchers and health professionals.

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