André Moreira Castilho

CORRELAÇÃO INTEROBSERVADOR DOS PARÂMETROS DO EXAME FÍSICO VERIFICADOS EM UM APLICATIVO PARA RASTREIO DE ESCOLIOSE IDIOPÁTICA

Dissertação apresentada à Universidade de Caxias do Sul, para obtenção do Título de Mestre em Ciências da Saúde.

Caxias do sul

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Orientador: Prof. Dr. Asdrúbal Falavigna

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Dedicatória

Dedico a minha esposa, Ana Luiza que sempre apoiou minha empreitada e me ajudou durante toda essa importante etapa da minha vida. Obrigado pela compreensão, companheirismo, amor e especialmente por me proporcionar a estrutura e tranquilidade necessárias para conseguir concluir essa jornada.

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1 INTRODUÇÃO

A escoliose é uma patologia da coluna vertebral prevalente entre crianças, adolescentes e adultos jovens(1, 2). A escoliose atinge cerca de 1% a 13,8% das crianças e adolescentes(1, 2, 5, 6). Havendo uma incidência razoavelmente maior entre meninas do que entre meninos, especialmente, quando se trata de curvaturas mais acentuadas, ressaltando que as meninas são mais suscetíveis à progressão da curvatura(1, 5-9).

A escoliose é definida como uma curvatura lateral da coluna vertebral igual ou superior a 10º (dez graus), diagnosticada através do exame radiográfico simples(1, 2, 10-12). Normalmente, os pacientes com escoliose apresentam ampla capacidade funcional torácica e de membros(13). Entretanto, casos de diagnóstico tardio que apresentem progressão da curvatura, podem cursar com complicações cardiopulmonares pela deformidade da caixa torácica(1, 2, 14). O tratamento dos pacientes com escoliose varia desde a observação, uso do colete e a cirurgia, estando o prognóstico relacionado ao grau de curvatura(1, 2, 11). Sendo assim, o diagnóstico precoce é fundamental para orientar seu tratamento e evitar a progressão da curvatura.

Os principais achados da escoliose no exame físico são a assimetria dos ombros, escápulas, cintura, tronco e costelas(1). O teste de Adams avalia a presença de giba e quantifica a curvatura lateral, sendo considerado fundamental para rastreio de escoliose nas escolas(2, 5, 6).

Devido à prevalência especialmente alta entre crianças e adolescentes, o rastreio da escoliose tem sido amplamente realizado em escolas, proporcionando um aumento na eficácia das medidas de tratamento e prevenção(14-16). Estudo realizado em Hong Kong demonstrou que o custo total do rastreio, diagnóstico e acompanhamento – cerca de 3 milhões de dólares – é facilmente compensado se pelo menos 152 crianças receberem tratamento conservador que elimine a necessidade de cirurgia(17). O trabalho publicado por um grupo de pesquisa da Universidade de Caxias do Sul, apontou que as cirurgias de coluna representaram um gasto para o Sistema Único de Saúde (SUS) em 2014 de R$ 146.500.000,00, sem considerar gastos com cuidados não-operatórios, procedimentos diagnósticos, e custos relacionados à perda de produtividade e invalidez (18).

A política de rastreio tem sido amplamente debatida, e várias são as críticas relacionadas a seu custo-benefício, bem como ao número de encaminhamentos e exames adicionais desnecessários(5, 9, 15). Ainda assim, o diagnóstico precoce é crucial para a redução de morbidades associadas a escoliose.

O objetivo do trabalho é verificar os parâmetros de maior correlação interobservador das diversas variáveis do exame físico da escoliose idiopática com auxílio de um aplicativo desenvolvido para *smartphone*. Nosso estudo servirá como base para a futura validação do aplicativo como ferramenta efetiva no ratreio da escoliose idiopática.

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3 ARTIGO

Medicine

Interobserver findings in the validation process of a Smartphone Application as a Tool for Screening patients with scoliosis

--Manuscript Draft--

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Abstract:	Background : Scoliosis is a spinal condition that is common among children, adolescents, and young adults, affecting approximately 1%–13% of children and adolescents worldwide. Early diagnosis of scoliosis allows treatment in its initial stages and avoids surgical treatment and deformity progression. The present study aims to analyze the best correlated clinical parameters among examiners using an application for smartphone developed for screening of idiopathic scoliosis and to evaluate the friendly use of this application. Methods : This study assesses a smartphone mobile application that analyzes several clinical parameters related to the changes observed in scoliosis. Comparative analyses between medical and non-medical examiners were performed to define parameters with the greatest inter-observer correlation. Results : 89 participants have been examined, 18 were women and 71 were men. Two subjects were excluded from the analysis. The mean age of subjects from the public school was 11.30 years and from the sports club was 11.92 years. None of the parameters between examiners achieved perfect concordance. Substantial concordance was noted in reduced lordosis and mid-thoracic scoliometer. Moderate concordance was noted in pelvic asymmetry (frontal). Fair agreement was achieved in increased kyphosis, presence of a hump (frontal), waist asymmetry (frontal), ribcage asymmetry (frontal) and pelvic asymmetry (frontal). Conclusions : Screening for idiopathic scoliosis is a public health concern. The search for a tool that is inexpensive and technically and clinically effective is the final objective of our research. This is a preliminary study that will help to achieve our final goal that is the validation of an effective tool that can be used by nonmedical professional in the idiopathic scoliosis screening. Level of Evidence: III

Interobserver findings in the validation process of a Smartphone Application as a Tool for Screening patients with scoliosis

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Abstract

Background: Scoliosis is a spinal condition that is common among children, adolescents, and young adults, affecting approximately 1%–13% of children and adolescents worldwide. Early diagnosis of scoliosis allows treatment in its initial stages and avoids surgical treatment and deformity progression. The present study aims to analyze the best correlated clinical parameters among examiners using an application for smartphone developed for screening of idiopathic scoliosis and to evaluate the friendly use of this application.

Methods: This study assesses a smartphone mobile application that analyzes several clinical parameters related to the changes observed in scoliosis. Comparative analyses between medical and non-medical examiners were performed to define parameters with the greatest inter-observer correlation.

Results: 89 participants have been examined, 18 were women and 71 were men. Two subjects were excluded from the analysis. The mean age of subjects from the public school was 11.30 years and from the sports club was 11.92 years. None of the parameters between examiners achieved perfect concordance. Substantial concordance was noted in reduced lordosis and mid-thoracic scoliometer. Moderate concordance was noted in pelvic asymmetry (frontal). Fair agreement was achieved in increased kyphosis, presence of a hump (frontal), waist asymmetry (frontal), ribcage asymmetry (frontal) and pelvic asymmetry (frontal).

Conclusions: Screening for idiopathic scoliosis is a public health concern. The search for a tool that is inexpensive and technically and clinically effective is the final objective of our research. This is a preliminary study that will help to achieve our final goal that is the validation of an effective tool that can be used by nonmedical professional in the idiopathic scoliosis screening.

Level of Evidence: III

Introduction

Scoliosis is a spinal condition that is common among children, adolescents, and young adults.[1, 2] It affects approximately 1%–13% of children and adolescents worldwide.[1, 2, 5, 6] Most patients with scoliosis have a mild abnormal curvature of the spine and the curvature does not progress in adulthood.[2] However, a more pronounced curvature and a late diagnosis can lead to cardiopulmonary complications and reduced quality of life of patients.[1, 3] Early diagnosis of scoliosis allows timely treatment of the condition in its initial stages, further avoiding surgical treatment and deformity progression.[1] Screening of idiopathic scoliosis is widely discussed in medical literature.[4] It has been performed in schools because of its high prevalence among children and adolescents, increasing the efficacy of treatment and prevention measures and reducing the costs with surgery.[7-9] Main findings of scoliosis on physical examination are asymmetry of the shoulders, scapulae, pelvis, trunk, and ribcage.[1] Adam's forward bend test is used to assess the presence of a hump and quantify the lateral curvature; it is considered essential for the screening of scoliosis in schools.[2, 5, 6]

The screening policy has been a subject of debated and there are several criticisms on the related cost/benefit ratio, number of referrals, and unnecessary additional exams. [5, 7, 10] Nevertheless, early diagnosis is still crucial for reducing morbidities associated with scoliosis.

The present study aims to analyze the best correlated clinical parameters among examiners using an application (app) for smartphone developed for screening of idiopathic scoliosis and to evaluate the friendly use of this app.

Methods

Type of study

We performed a cross-sectional study conducted to assess idiopathic scoliosis among students aged 8–17 years of a public and a private school and an athletic club of Belo Horizonte, Minas Gerais, Brazil.

The project was approved by the Ethics Committee of a Hospital Mater Dei in Belo Horizonte Certificate of Presentation for Ethical Assessment — CAAE no.

07926919.5.0000.5128). The patient's confidentiality and privacy will be guaranteed throughout all stages of the study, according to medical ethics principles.

Eligibility Criteria

Inclusion criteria

1. Students at a public school, a private school and athletes of a Sports Club in the Municipality of Belo Horizonte who were aged 8–17 years, who accepted to participate willingly in the study and signed a consent informed document. The participants' guardians need also to sign an informed consent form.

Exclusion criteria

1. Previous spine surgery.
2. Previous diagnosis and treatment of scoliosis.
3. Diseases of the nervous system that compromise ambulation.
4. Understanding or cognitive problems.

Sample size calculation

Post hoc sample size calculation was done using the software R utilizing the cohen. kappa (irr) with a concordance level of 5% and a confidence interval of 95%. Considering all variables analyzed and compared with each examiner the average number of participants was 88 (minimum 56 and maximum 145).

Study Locations

The locations were selected based on those that were the most representative of the sample: a public school in the municipality of Belo Horizonte and a private sports club in Belo Horizonte. The data was first collected in the public school. Owing to bureaucratic difficulties in public school and also to have a more heterogeneous sample we extended the locations to the sports club and to a private school. In these two locations we had a more controlled enviromment. In the sport club we started the survey between boys, all basketball players, and before we could enroll the female group in the analysis, we had to stop our study because of the COVID 19 pandemic. We also could not evaluate the students at the private school for the same reason.

Selection and training of examiners

The examiners were selected aiming to include at least one examiner who was experienced in the evaluation of individuals with adolescent idiopathic scoliosis (gold-standard examiner), one orthopedist specializing in spine surgery (inexperienced medical examiner), and one non-medical examiner.

The examiners were trained for this activity and supervised by the principal researcher specialized in scoliosis. The team of examiners was composed of one orthopedist specialized in spine surgery (ExL), one surgical instrument nursing technician (Ex1), and one orthopedist in the first year of training in spine surgery (Ex2).

Description of the application

The children and adolescents were evaluated by the Scoliosis Screen mobile app, available for iOS or Android (see electronic attachment: **https://youtu.be/fs3aNbNf404**). The application was developed in University of Caxias do Sul and is available in Brazilian Apple and Google store. The evaluators were trained for using the software app and its tutorials.

Analyzed variables

The application assesses the following variables: head, shoulder, waist, ribcage, and pelvic asymmetry from anterior and posterior view, the presence of kyphosis and of a hump (Adam's test); and, finally, the measurement of an upper, mid, and lower thoracic scoliosis using the scoliometer (included in the sequence of evaluation utilizing the accelerometer of the smartphone). The interobserver correlation between these variables among the examiners was analyzed and also the time spent with each subjected was measured and compared.

Phases of the evaluation

The examination of each subject was conducted by two alternate examiners in the following manner: - Ex1 – ExL; Ex1 – Ex2. The subjects wore a short-sleeved T-shirt and shorts or a jersey jacket. The examination was conducted in a reserved and quiet environment. The subjects who presented with Adam's test positive, shoulder asymmetry, and a reading of >2° on the scoliometer will be invited to attend a free consultation with the leading researcher. This clinical criterial were chosen in this first moment to increase the sensibility of the evaluation, projecting a second evaluation with main examiner in an attempt to validate the app. The leading researcher receives an email from the application whenever the alterations are detected and sends a letter to the guardians inviting them to the specialized medical consultation.

Evaluation of the application

The examiners were invited to answer the post study system usability questionnaire (PSSUQ) [11, 12] , to evaluate the software app. The survey is composed of 19 items scored from 1 to 7, varying from "strongly disagree" to "strongly agree."

The items analyzed were easiness, simplicity, effectiveness, ability to complete tasks quickly, ability to complete tasks, comfort, easiness to learn, productivity possibility, system capacity to fix problems, ability to solve mistakes, quality system information, accessibility to information, system information compression, system Information effectiveness, system Information organization, system interface, system interface satisfaction, system expectations, and system overall satisfaction.

Statistical analysis

The data collected were initially entered into an Excel (2013) spreadsheet and subsequently analyzed using the SPSS (26.0) statistical package. The normality of the continuous data was assessed using the Shapiro–Wilk test. Anthropometric data were expressed as means, standard deviations, medians, and minimum and maximum values. The examination time between the researcher and the examiner was compared using the Mann-Whitney U test. The changes observed on physical examination were presented in contingency tables and expressed as absolute (n) and relative (%) frequencies. The agreement between the researcher and the examiner was assessed with the Kappa test. The level of significance was set at 5% ($p < 0.05$) in all analyses.

Results

Anthropometric Data

Data collection was performed between August and December 2019. The number of participants were 89. Of these, 18 were women and 71 were men. Two subjects were excluded from the analysis, namely one subject who had already been diagnosed with neuromuscular scoliosis and one with adolescent idiopathic scoliosis under medical monitoring. The mean age of subjects from the public school was 11.3 years, the mean weight 39,0kg, mean height 1,5 meters and 17,9 the mean BMI (body mass index) (table 1). In the sports club mean age was 11.92 years, the mean weight 61,2kg, mean height 1,71 meters and 20,3 the mean BMI (table 2).

Time Evaluation

The mean time for subject examination was 57.18 seconds for ExL compared to 68.36 seconds for Ex1 (figure 1) and the mean time for subject examination was 56.45 seconds for Ex1 compared to 56.25 seconds for Ex2 (figure 2).

General Assessment and Interobserver Correlations

ExL evaluated 54 individuals and referred 11 for re-assessment. Nine of these had shoulder asymmetry and two had a curvature with a rotation of >2°. Ex1 evaluated 87 individuals and referred 24 for re-assessment. Twenty-four of these had shoulder asymmetry, 5 had a hump, and 5 had changes in the scoliometer readings. Ex2 evaluated 33 individuals and referred 11 of these, all with shoulder asymmetry. Tables 3 and 4 show the analysis of all variables and the positive correlations between the examiners.

None of the parameters between ExL and Ex1 achieved almost perfect concordance. Substantial concordance was noted in reduced lordosis and mid-thoracic scoliometer. Fair agreement was achieved in increased kyphosis, presence of a hump (frontal) and waist asymmetry (frontal). All the other parameters had slight or poor agreement. The presence of a hump, scapular asymmetry and waist asymmetry (posterior) were statistically significant changes found between ExL and Ex1. In subjects diagnosed with shoulder asymmetry, scapular (posterior), waist and pelvic (posterior and frontal), ribcage (frontal) asymmetry was found between ExL and Ex1 with statistical difference.

None of the parameters between Ex1 and Ex2 achieved almost perfect and substantial concordance. Moderate concordance was noted in pelvic asymmetry (frontal). Ribcage asymmetry (frontal) and pelvic asymmetry (frontal) had fair concordance. In subjects diagnosed with shoulder asymmetry, scapular (posterior), waist and pelvic (posterior and frontal), ribcage (frontal) asymmetry had statistically significant concordance between Ex1 and Ex2.

App Evaluation

The results of the app evaluation showed complete satisfaction of users in effectiveness, easiness to learn, productive possibility and system interface satisfaction. The worst results in the evaluation were easiness to use and capacity of solving problems by the system and the user (table 5).

Discussion

This study is the first to evaluate almost all the parameters in the physical examination between medical and nonmedical examiners in an attempt to improve the

screening of adolescent idiopathic scoliosis. Our findings showed that reduced lordosis, mid thoracic scoliometer, presence of hump, waist asymmetry, increased kyphosis, ribcage asymmetry and pelvic asymmetry had substantial to fair concordance. Shoulder asymmetry, one the parameters used as an alert in the app showed a poor interobserver correlation. The mean time spent assessment was, initially, significantly slower for the nonmedical examiner (first group analysis) but improved considerably in the subsequent analysis (second group) probably because the nonmedical examiner gained experience from using the app. Also, the app interface was proven to be friendly.

Adolescent idiopathic scoliosis is a common condition in the population worldwide and has a high morbidity rate. [1], [3] Self-reported poor health, poor self-image and restricted social interaction are expected outcomes among patients whose deformities are maintained or progress during adulthood. [3] Failure to detect scoliosis at an early stage increases the risk of progression and severity of the disease. [13]

Screening of adolescent idiopathic scoliosis is a widely discussed topic in the literature. [4] The first screening program was implemented in 1962[14] in Delaware, USA, after Shands et al., from the Alfred DuPont Hospital, warned about the prevalence of idiopathic scoliosis in adolescents. In the following years, the number of American states that adhered to the screening program increased, reaching over 20 states in 1989. [14] In 2004, the US Preventive Service Task Force (USPFTS) advised against screening because of the high number of false positives, particularly in Adam's forward bend test. [15]

The Scoliosis Research Society (SRS), taking the determination of the USPFTS into account, initiated a study to determine the effectiveness of adolescent idiopathic scoliosis screening. A group of experts was established to study the variables related to screening effectiveness. [16] Clinical and technical programs, costs and treatment effectiveness were assessed. After the analysis of key questions in the medical literature, the SRS screening recommendations were published in 2013. [17] The prevalence of adolescent idiopathic scoliosis, the proportion of patients referred to radiographic evaluation, and the positive predictive value are indicators of clinical effectiveness. A scoliometer is the best evaluation tool, combined with or without Adam's forward bend test. The analysis for Moiré topography can increase the sensitivity and specificity of the screening. The program recommends the evaluation

of girls aged 10–12 years and boys aged 13–14 years. The identification of patients in the initial stages of the disease allows early treatment with an orthopedic corset and reduces the risk of progression to severe deformities, thus indicating the effectiveness of the screening program. Evidence on cost-effectiveness in the literature remains insufficient.

The total cost of screening, diagnosing, and monitoring — approximately three million dollars — can be easily compensated if at least 152 children receive conservative treatment that eliminates the need for surgery[18] A study published by a research group of the University of Caxias do Sul indicated that in 2014, spine surgeries cost Brazil's national health system – Sistema Único de Saúde (SUS) – 146.5 million Brazilian reais, excluding expenses with non-surgical care, diagnostic procedures, and costs associated with loss of productivity and disability[19].

Numerous screening tools have been proposed for the detection of adolescent idiopathic scoliosis, of which measurement with a scoliometer is the most popular.[20] Several mobile applications have been validated after comparison with the scoliometer and have become useful tools for in-office evaluation by specialists and in the screening of adolescent idiopathic scoliosis.[21-24] Naziri et al. conducted an assessment of available scoliometer mobile applications and concluded that the tools are at least as effective as the manual scoliometer, possibly more, with no difference between paid and free apps.[25]

In recent years, the growth of smartphone use has revolutionized the access of medical professionals to information. According to Franko et al. [21] 84% of resident orthopedists and non-medical professionals in orthopedic teams use smartphones and 53% of them use mobile applications in clinical practice, and this number is probably higher now.

Most applications for the screening of scoliosis only use the scoliometer as a measure. Fong et al. demonstrated that screening performed using only Adam's forward bend test is insufficient and results in a high rate of false positives. [4] The combination of the scoliometer, Adam's forward bend test, and Moiré topography has a sensitivity and specificity close to 94% and 99%, respectively. [3]

Our study presents a simplified alternative for adolescent idiopathic scoliosis screening. Most screening studies have been conducted with the assistance of medical professionals, which entails a high healthcare cost.

The inclusion of several physical examination parameters of a patient with scoliosis will allow an evaluation of which parameters present the greatest agreement, while outpatient assessment by a spine specialist will permit the validation of the application as a screening tool. In our initial results reduced lordosis, mid-thoracic scoliometer and pelvic asymmetry (frontal) had better agreement between examiners. These parameters needed to be checked in outpatient assessment to be validated.

This study had some limitations. The difficulty of data collection was one of the study's limitations. There was also greater difficulty because of COVID 19. Since this is a screening study, our sample is still not sufficiently representative, and another study will be required for further assessment and interpretation of the data. The application will require refinements to improve data storage and export. Time was measured by the examiners themselves, which represents a significant bias in the evaluation of this variable.

The quality of the comparative analysis will improve once we obtain the data from the paired comparison between the leading examiner and other non-medical examiners (considering that the data collected so far were provided by only one non-medical examiner). It is important to analyze the results of the physical examination and X-ray after referral of individuals in whom the application showed alterations to a specialist. We will then be able to validate the tool as a screening method. It is interesting to observe that the time between medical and non-medical examiner was similar. There was a reduction for the non-medical examiner in the duration of the evaluation comparing the first and second event.

Regarding future prospects, the main objective of the study is to create a simple and effective tool for the screening of adolescent idiopathic scoliosis by non-medical professionals, especially in the school environment. This study set the base for future creation of a simple and effective tool for the screening of idiomatic scoliosis. The final data analysis will allow making adjustments to the smartphone application that will ensure the ease of understanding and use of the tool and increase its sensitivity and specificity in the detection of the condition. The improved cost/benefit ratio will allow cities and states to diagnose and treat adolescent idiopathic scoliosis at an early stage. A more representative sample and a larger number of examiners will be necessary to test the tool's applicability. The. PSSUQ results shows that the application has friendly use in terms of simplicity, easiness and effectiveness. It also shows that some

modifications are needed to make it easier and more resolutive in solving problems. Another possibility is providing a simplified tutorial for the users.

In conclusion, screening for idiopathic scoliosis is a public health concern. This is a preliminary study that will help to achieve our final goal that is the validation of an effective tool that can be used by nonmedical professional in the idiopathic scoliosis screening.

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Figure legends

Figure 1. Boxplot comparing the duration of the evaluation among the examiners

*Mann–Whitney U test

Figure 2. Boxplot comparing the duration of the evaluation among the examiners

*Mann–Whitney U test

Table 1. Description of age and anthropometric profile of the adolescents from the public school by different examiners

Table 2. Description of age and anthropometric profile of the adolescents from sport club by different examiners

Table 3. Analysis of the agreement on the changes on physical examination between the examiners ExL and Ex1

Table 4. Analysis of the agreement on the changes on physical examination between the examiners Ex1 and Ex2

Table 5. Description statistics of the examiners' evaluation.

Fig 1.

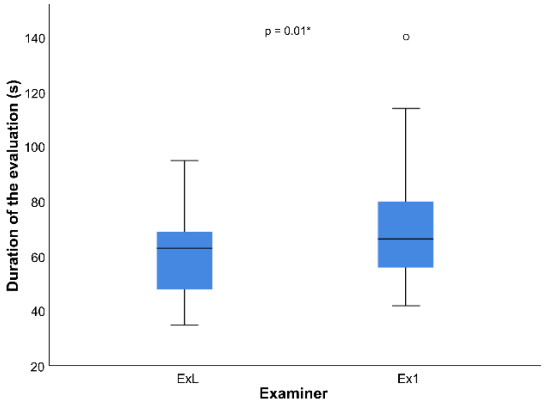

p = 0.01*
Duration of the evaluation (s)
140
120
100
80
60
40
20
ExL
Ex1
Examiner

Fig 2.

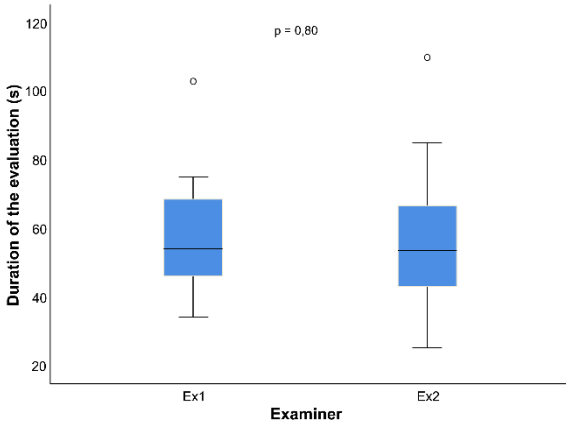

p = 0,80
Duration of the evaluation (s)
120
100
80
60
40
20
Ex1
Ex2
Examiner

Table 1. Description of age and anthropometric profile of the adolescents from the public school by different examiners

	Mean	SD	Median	Minimum	Maximum
Age of the adolescent (years)	11.3	1.5	11.0	9.0	16.0
Weight (kg)	39.0	8.5	38.0	23.0	57.00
Height (cm)	150.0	10.0	152.0	130.0	163.0
BMI	17.9	2.2	17.5	14.3	21.6

SD, Standard deviation; BMI, Body Mass Index

Table 2. Description of age and anthropometric profile of the adolescents from sport club by different examiners

	Mean	SD	Median	Minimum	Maximum
Age of the adolescent (years)	11.9	1.4	12.0	8.0	14.0
Weight (kg)	61.2	19.1	56.0	34.0	99.0
Height (cm)	171.0	13.0	171.0	147.0	191.0
BMI	20.3	4.2	19.8	15.5	30.3

SD, Standard deviation; BMI, Body Mass Index

Table 3. Analysis of the agreement on the changes on physical examination between the examiners ExL and Ex1

	ExL n (%)	**Ex1 n (%)**	**Total**	***kappa***	***P***
Head asymmetry (Posterior)	0 (0.0)	0 (0.0)	0 (0.0)	na	na
Shoulder asymmetry (Posterior)	9 (16.7)	12 (22.2)	21 (19.4)	0.0	1.00
Scapular asymmetry (Posterior)	8 (14.8)	11 (20.4)	19 (17.6)	-0.08	0.54
Waist asymmetry (Posterior)	3 (5.6)	16 (29.6)	19 (17.6)	0.13	0.15
Pelvis asymmetry (Posterior)	4 (7.4)	13 (24.1)	17 (15.7)	0.14	0.20
Increased kyphosis	2 (3.7)	8 (14.8)	10 (9.3)	**0.36**	**0.01**
Reduced kyphosis	8 (14.8)	5 (9.3)	13 (12.0)	0.22	0.09
Increased lordosis	9 (16.7)	12 (22.2)	21 (19.4)	0.0	1.00
Reduced lordosis	3 (5.6)	2 (3.7)	5 (4.6)	**0.79**	**< 0.01**
Presence of a hump (Frontal)	2 (3.7)	4 (7.4)	6 (5.6)	**0.30**	**0.02**
Head asymmetry (Frontal)	1 (1.9)	0 (0.0)	1 (0.9)	na	na
Shoulder asymmetry (Frontal)	14 (25.9)	13 (24.1)	27 (25.0)	0.16	0.23
Ribcage asymmetry (Frontal)	4 (7.4)	4 (7.4)	8 (7.4)	0.19	0.16
Waist asymmetry (Frontal)	7 (13.0)	13 (24.1)	20 (18.5)	**0.29**	**0.03**
Pelvis asymmetry (Frontal)	5 (9.3)	14 (25.9)	19 (17.6)	0.08	0.45
Upper thoracic scoliometer	0 (0.0)	3 (5.6)	3 (2.8)	na	na
Mid-thoracic scoliometer	1 (1.9)	2 (3.7)	3 (2.8)	**0.66**	**< 0.01**
Lower thoracic scoliometer	1 (1.9)	3 (5.6)	4 (3.7)	- 0.03	0.80

ExL, examiner orthopedist specializing in spine surgery; n, absolute frequency; %, relative frequency; Ex1, examiner surgical instrument technician; *kappa,* Kappa test; na, not applicable

Table 4. Analysis of the agreement on the changes on physical examination between the examiners Ex1 and Ex2

	Ex1 n (%)	**Ex2 n (%)**	**Total**	***kappa***	***p***
Head asymmetry (Posterior)	0 (0.0)	1 (3.0)	1 (1.5)	0.00	1.00
Shoulder asymmetry (Posterior)	11 (33.3)	11 (33.3)	22 (33.3)	0.32	0.06
Scapular asymmetry (Posterior)	7 (21.2)	12 (36.4)	19 (28.8)	0.06	0.68
Waist asymmetry (Posterior)	8 (24.2)	9 (27.3)	17 (25.8)	0.29	0.09
Pelvic asymmetry (Posterior)	10 (30.3)	4 (12.1)	14 (21.2)	**0.31**	**0.03**
Increased kyphosis	9 (27.3)	3 (9.1)	12 (18.2)	0.03	0.80
Reduced kyphosis	1 (3.0)	1 (3.0)	2 (3.0)	−0.03	0.96
Increased lordosis	11 (33.3)	5 (15.2)	16 (24.2)	0.05	0.73
Reduced lordosis	1 (3.0)	2 (6.1)	3 (4.5)	−0.04	0.79
Presence of hump (Frontal)	1 (3.0)	0 (0.0)	1 (1.5)	0.00	1.00
Head asymmetry (Frontal)	0 (0.0)	1 (3.0)	1 (1.5)	0.00	1.00
Shoulder asymmetry (Frontal)	12 (36.4)	8 (24.2)	20 (30.3)	0.15	0.35
Ribcage asymmetry (Frontal)	4 (12.1)	10 (30.3)	14 (21.2)	**0.31**	**0.03**
Waist asymmetry (Frontal)	11 (33.3)	14 (42.4)	25 (37.9)	0.30	0.08
Pelvic asymmetry (Frontal)	13 (39.4)	11 (33.3)	24 (36.4)	**0.48**	**0.006**

Ex1, examiner surgical instrument technician; n, absolute frequency; %, relative frequency; Ex2 orthopedist in the first year of training in spine surgery; *kappa,* Kappa test; na, not applicable

Table 5. Description statistics of the examiners' evaluation.

	Mean	SD
Easiness	5.5	1.9
Simplicity	6.5	1.0
Effectiveness	7.0	0.0
Ability to complete tasks quickly	6.3	1.0
Ability to complete tasks	6.5	0.6
Comfort	6.5	1.0
Easiness to learn	7.0	0.0
Productivity possibility	7.0	0.0
System capacity to fix problems	5.5	1.0
Ability to solve mistakes	5.8	1.0
Quality system information	6.3	1.0
Accessibility to information	6.8	0.5
System infomation compreession	6.8	0.5
System information effectiveness	6.8	0.5
System information organization	6.5	1.0
System interface	7.0	0.0
System interface satisfaction	7.0	0.0
System expectations	6.5	1.0
System overall satisfaction	6.8	0.5

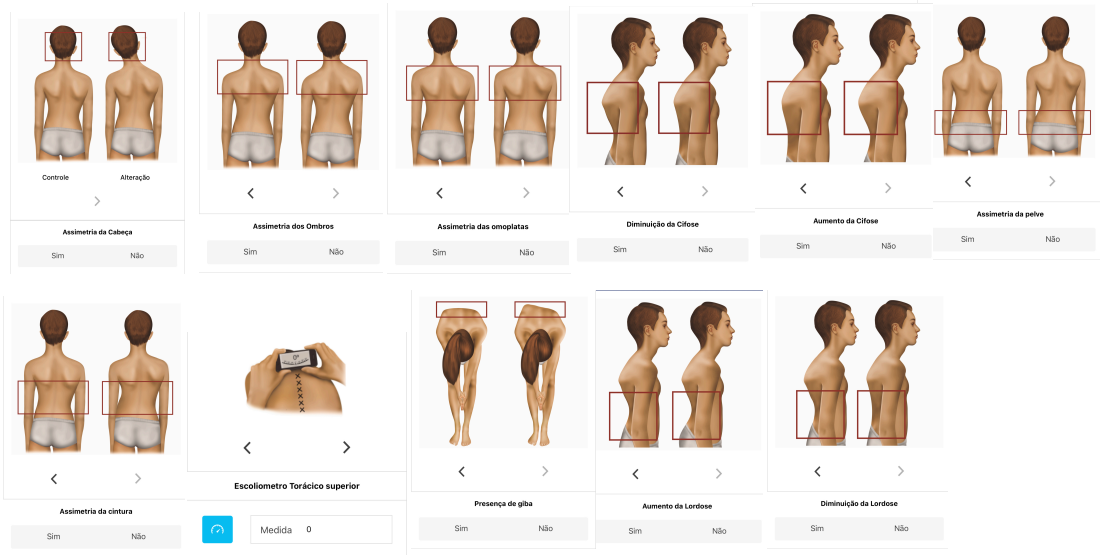
SD, Standard deviation

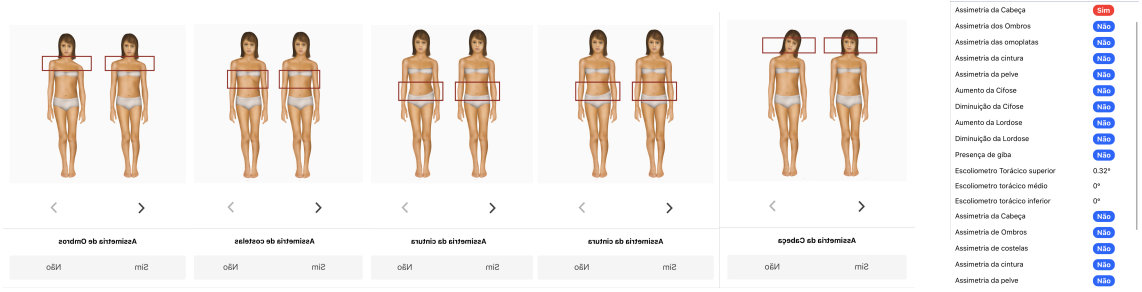
4 CONSIDERAÇÕES E PERSPECTIVAS FUTURAS

O objetivo principal do trabalho é criar uma ferramenta simples e eficiente para o rastreio de escoliose idiopática do adolescente por profissionais não médicos, especialmente em ambiente escolar. A análise dos dados, permitirá ajustes no aplicativo de smartphone que garantirão a facilidade no entendimento e aplicação da ferramenta, assim como sua maior sensibilidade e especificidade na identificação da doença. A melhor relação custo benefício, permitirá, aos municípios e estados, o diagnóstico e tratamento precoce da escoliose idiopática do adolescente. Uma amostra mais representativa será necessária, assim como um número maior de examinadores para testar a aplicabilidade da ferramenta.

O rastreio da escoliose idiopática do adolescente é uma preocupação de saúde pública. A busca por uma ferramenta que apresente efetividade técnica, clínica e de baixo custo é o objetivo do nosso trabalho. Este estudo preliminar definirá as bases para ajustar o aplicativo de smartphone desenvolvido para encontrarmos o resultado esperado.

Imagens do Aplicativo





Aplicabilidade: PSSUQ

Perguntas	Muito insatisfeito---------muito satisfeito						
No geral estou satisfeito com a facilidade de usar este sistema.	1	2	3	4	5	6	7
Foi simples de usar este sistema.	1	2	3	4	5	6	7
Eu poderia efetivamente completar as tarefas e cenários usando este sistema.	1	2	3	4	5	6	7
Consegui concluir as tarefas e cenários rapidamente usando este sistema.	1	2	3	4	5	6	7
Consegui concluir as tarefas e cenários eficientemente usando este sistema.	1	2	3	4	5	6	7
Eu me senti confortável usando este sistema.	1	2	3	4	5	6	7
Foi fácil aprender a usar este sistema.	1	2	3	4	5	6	7
Acredito que posso me tornar produtivo rapidamente usando este sistema.	1	2	3	4	5	6	7
O sistema deu mensagem de erro que me disseram claramente como corrigir os problemas.	1	2	3	4	5	6	7
Sempre que cometi um erro ao usar o sistema, eu consegui me recuperar com facilidade e rapidez.	1	2	3	4	5	6	7
As informações (como ajuda on-line, mensagens na tela e outras documentações) fornecidas com este sistema eram claras.	1	2	3	4	5	6	7
Foi fácil encontrar as informações que eu precisava.	1	2	3	4	5	6	7
As informações para o sistema eram fáceis de entender.	1	2	3	4	5	6	7
As informações foram eficazes e me ajudaram a completar as tarefas e cenários.	1	2	3	4	5	6	7
A organização das informações nas telas do sistema foi clara.	1	2	3	4	5	6	7
A interface deste sistema foi agradável.	1	2	3	4	5	6	7
Eu gostei de usar a interface deste sistema.	1	2	3	4	5	6	7
Este sistema tem todas as funções e capacidades que eu espero que ele tenha.	1	2	3	4	5	6	7
No geral estou satisfeito com este sistema.	1	2	3	4	5	6	7

CORRELAÇÃO INTEROBSERVADOR DOS PARÂMETROS DO EXAME FÍSICO VERIFICADOS EM UM APLICATIVO PARA RASTREIO DE ESCOLIOSE IDIOPÁTICA

André Moreira Castilho

Dissertação de Mestrado submetida à Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em Ciências da Saúde da Universidade de Caxias do Sul, como parte dos requisitos necessários para a obtenção do título de Mestre em Ciências da Saúde, Linha de Pesquisa: Investigação Clínica e Epidemiológica

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