



DIAGNOSTIC METHODS: RELIABILITY STUDY

Reliability of two pragmatic tools for assessing *text neck*

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ABSTRACT

Background: There is a hypothesis that the growing use of mobile phones in an inappropriate posture to text and read (*text neck*) could be a reason for the increasing prevalence of neck pain in the past decade. Before testing if there is an association between *text neck* and neck pain, it is necessary to develop reliable pragmatic tools appropriate to epidemiological studies.

Objectives: The primary aim of this study was to assess the reliability of the self-perception of *text neck*, as well as the reliability of physiotherapists' classification of the *text neck*.

Methods: The convenience sample was composed of 113 high school students between 18 and 21 years old from a cross-sectional study. As their self-perceived posture, participants had to choose in a questionnaire one of four neck postures of a person texting on a mobile phone. The physiotherapists classified lateral photographs taken with the participants texting on a mobile phone in their habitual posture as 1 (normal), 2 (acceptable), 3 (inappropriate), and 4 (excessively inappropriate).

Results: The results showed that the test–retest reliability of the self-perception was substantial ($\kappa = 0.73$, 95% CI 0.54 to 0.86). The reliability of the physiotherapists' responses, according to the photographic analysis considering the three raters, was moderate ($\kappa = 0.5$, 95% CI 0.39 to 0.61). Seventy-six percent of the participants with appropriate posture in the photographic analysis self-reported an inappropriate posture.

Conclusion: This study showed that the self-perception of the neck posture during mobile phone texting is reliable over time and that the physiotherapists' classification based on photographic analysis was acceptable for epidemiological studies. Participants had a tendency to report that the posture was worse than it actually was in the photographic analysis performed by the physiotherapists.

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1. Introduction

Neck pain is one of the four primary causes of disability around the globe (Hoy et al., 2014a). The prevalence of neck pain has increased considerably in the past decade and is almost the same in late adolescence as in adults (Hakala et al., 2002; Fejer et al., 2006; Hoy et al., 2014b; Myrteit et al., 2014; Ståhl et al., 2014; Meziat

Filho et al., 2016a,b). There has been a harmful increased use of and addiction to mobile phones for texting, especially among young people, in recent years, combined with the growing prevalence of neck pain (Nordicom, 2010; Hoy et al., 2014b; Lin et al., 2015; IBGE, 2011). This situation raises a hypothesis, based on biomechanics, that the inappropriate neck posture to text and read on mobile phones could be one of the reasons for the increasing prevalence of neck pain (Gustafsson et al., 2011; Gustafsson, 2012; Hansraj, 2014; Guan et al., 2015). In a recent longitudinal study, Gustafsson et al. (2017) found an association between texting on mobile phones and the persistence of neck pain. However, this study did not assess the type of neck posture adopted during mobile phone use.

Before testing if there is an association between *text neck* and neck pain, it is necessary to develop a reliable and pragmatic tool to assess this new exposure. Therefore, the primary aim of this study

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was to investigate the reliability of the self-perception of the neck posture during mobile phone use, as well as the reliability of physiotherapists' judgment of the neck posture during the same task. The secondary aim was to investigate the accuracy of the self-perception when compared to the physiotherapists' judgment.

2. Methods

The convenience sample was composed of 113 high school students between 18 and 21 years old from a cross-sectional study, developed in a public high school in the city of Rio de Janeiro. The exclusion criteria were pregnancy and spinal surgery or any musculoskeletal or neurological diseases that did not allow a standing posture. This study follows the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) (Kottner et al., 2011). The research was approved by the Augusto Motta University Centre Ethics Committee (CAAE 55790816.6.0000.5235). All participants were informed of the objectives and procedures of the study and signed an informed consent form, including consent to use their image.

2.1. Measures

In the self-report questionnaire, the participants answered sociodemographic (age, gender) and anthropometric (weight, height) questions. The time spent using a mobile phone was assessed with the question: 'On a regular day, how long do you spend reading, texting and playing on your mobile phone?' The nine response options were: 'I use a mobile phone only to talk', 'less than 1 h', 'about 1 h' ranging to 'about 7 h or more'. The questions about vision problems were: 'Do you have a visual impairment?' (response options: 'yes' or 'no') and 'If you have a visual impairment, do you wear glasses or lenses?' (response options: 'yes', 'no', or 'yes, but I am not wearing them today').

To assess the concern about the body posture, we asked the following question: 'How often do you worry about your body posture?' The response options were: 'very often', 'often', 'once in a while', 'rarely', or 'never'.

2.2. Self-perception

The self-perception of *text neck* during mobile phone use was assessed using a question with illustrations of four neck postures of a person texting on a mobile phone (Fig. 1). The participants responded the question twice within a period of seven days. Prior to the study, the question with the illustrations was assessed by an expert committee of three physiotherapists specialised in musculoskeletal pain, with the aim of developing the final version. The committee suggested a fifth response option for the participants who did not know their posture.

2.3. Photographic analysis

Lateral photographs were taken with the subjects standing in their habitual posture at a mark on the floor as in a previous study (Meziat-Filho et al., 2016a,b). The verbal command was: 'stand normally, relax, and type the text: "the thing I like to do most is ..." in your mobile phone.' Photographs (4608 x 2592 pixels) were taken with a digital camera (Sony DSC-H100, Japan) placed on a tripod 80 cm high and 250 cm lateral to the participant. The photographs were digitised and sent to two raters with 10 years of clinical experience (rater 1 and 2) in musculoskeletal physiotherapy and to one rater with 17 years of clinical experience (rater 3). The raters were instructed to pragmatically classify the postures based on the magnitude of the protrusion and flexion of the head in the

image as 1 (normal), 2 (acceptable), 3 (inappropriate), and 4 (excessively inappropriate) (Fig. 2). The results of the classification were analysed as a binary variable (0-0-1-1). For the accuracy analysis, the variable *physiotherapists' judgment* was created considering the decision made according to the absolute agreement of at least two out of the three raters. In other words, the *physiotherapists' judgment* was the combination of the result of the three dichotomised variables from each physiotherapist's judgment.

2.4. Statistical analysis

Participants' characteristics were described using proportions and mean and standard deviations. Both the *self-perception* and the *photographic analysis* of the neck posture were analysed as dichotomous variables (normal or acceptable as a category and inappropriate and excessively inappropriate as the other category) for both the reliability and the accuracy analysis. The test–retest reliability of the self-perception of the neck posture and the inter-rater reliability of the *photographic analysis* were quantified by the percentage agreement and by the Light's kappa coefficient (k) with 95% CI. The k coefficient was interpreted according to Landis and Koch (1977) criteria. The k values between 1.0 and 0.8 were considered almost perfect, between 0.79 and 0.6 as substantial, between 0.59 and 0.4 as moderate, between 0.39 and 0.2 as fair, between 0.19 and 0 as poor, and lower than 0 without agreement.

For the accuracy analysis, sensitivity, specificity, LR+ and LR-, and respective 95% CI were calculated using a 2×2 table, considering the self-perception of inappropriate or excessively inappropriate as a positive test. All analyses were performed using the RStudio version 0.99.486. The accuracy analysis was accomplished using the package *epiR*, and the interpretation of the validity of the self-report was performed using the McGee (2002) method.

3. Results

Our sample was comprised of mostly males (54%, $n = 61$), with a mean age of 18.4 (SD = 0.7) years (Table 1). The majority of the participants (81.5%) reported more than 4 h of mobile phone use per day. Almost half of the participants (45.1%) had vision impairments. Of those participants with vision impairments, 27.5% did not wear glasses or lenses at all, and 7.8% forgot to bring their glasses and therefore were not wearing them in the pictures taken. A proportion of 85.8% of the participants reported that they had been concerned with their posture at least once in a while. Considering the four illustrations of posture (Fig. 1) from left to right, the majority of the participants chose the third option (57.6%), followed by the fourth (24.8%), the second (15.0%), and the first option (0.3%). None of the participants reported to not know their posture.

The test–retest percentage agreement of the *self-perception* of the posture during mobile phone use was 91.1%, and the k coefficient was substantial (Fig. 3). The percentage agreement of the three raters regarding the *photographic analysis* of the posture during mobile phone use was 66.2%, and the k coefficient was moderate (Fig. 4).

The percentage agreement between rater 1 and 2 was 67.3%, and the reliability was fair ($k = 0.38$, 95% CI 0.23 to 0.54). The percentage agreement between rater 2 and 3 was 76.9%, and the reliability was moderate ($k = 0.53$, 95% CI 0.36 to 0.67). The percentage agreement between rater 1 and 3 was 78.8%, and the reliability was moderate ($k = 0.58$, 95% CI 0.42 to 0.72).

The accuracy of the self-perception when compared to the photographic analysis was low. The sensitivity was 0.88 (CI 95% 0.77 to 0.95), and the specificity was 0.24 (CI 95% 0.13 to 0.38). The positive likelihood ratio was 1.16 (CI 95% 0.97 to 1.39) and the

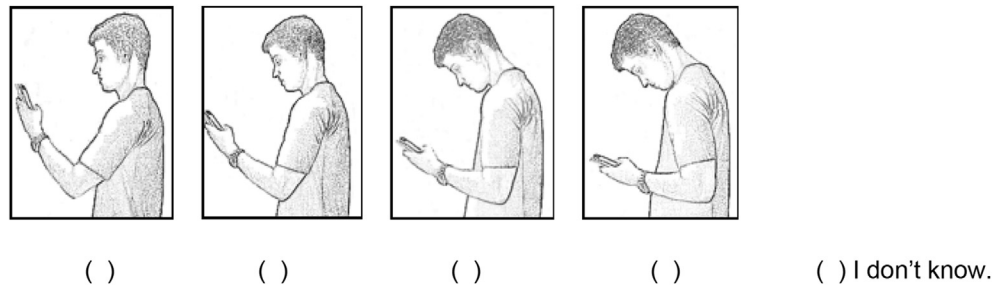


Fig. 1. Which is your most frequent position while using a mobile phone? Please choose one of the five options below.

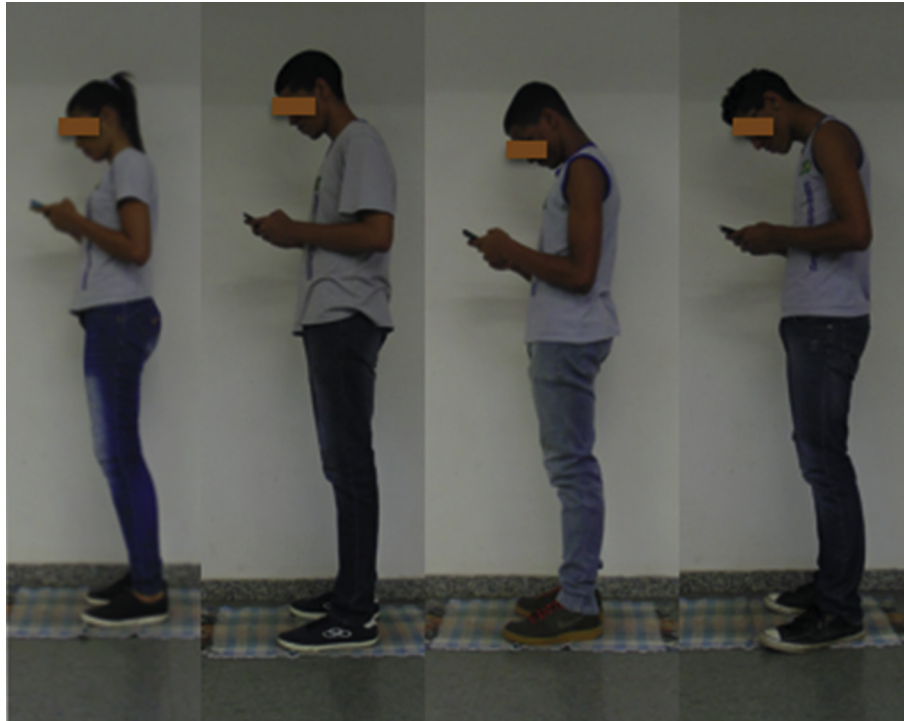


Fig. 2. The posture profile examples in sequence, from left to right: appropriate posture, acceptable posture, inappropriate posture, excessively inappropriate posture.

negative 0.49 (CI 95% 0.21 to 1.14).

The proportion of the participants with a visual impairment but without visual correction at the time of the assessment was not different between the two classifications of posture ($p = 0.94$).

4. Discussion

The present study showed that the self-perception of the neck posture during mobile phone texting is reliable over time, and that the photographic analysis, subjectively performed by physiotherapists, is acceptable to epidemiological studies. Interestingly, the test–retest reliability of the *self-perception* was better than the inter-rater reliability of the *physiotherapists' judgment*. Although the *self-perception* was assessed by the participants, the reliability was better than the physiotherapists' classification based on the pictures. This difference could be explained by the fact that the reliability of the photographic analysis tends to be greater over time than when different raters are being compared (Seah et al., 2011; Meziat-Filho et al., 2016a,b).

The accuracy analysis of the *self-perception* compared to the *physiotherapists' judgment* about the posture showed a low

Table 1

Characteristics of the participants.

Gender		Visual impairment	
Male	53.9% (61)	Yes	45.1% (51)
Female	46.1% (52)	No	54.9% (62)
Age (years)	18.4 (0.7)	Concern with posture	
Height (cm)	168.9 (9.3)	Often	7.1% (8)
Weight (kg)	66.63 (15.45)	Once and while	21.2% (24)
		Once or twice	57.5% (65)
		Rarely	11.5% (13)
		Never	2.7% (3)
Mobile phone use			
Only as a phone	0.1% (1)		
Less than 1 h	2.7% (3)		
Between 1 and 3 h	15% (17)		
Between 4 and 6 h	31.9% (36)		
7 h or more	49.6% (56)		

Categorical data are expressed in percentage and number of participants. Continuous data with normal distribution are expressed in mean and standard deviation.

specificity. The high number of false positives indicated that 76% of the participants with appropriate posture according to the *physiotherapists' judgment* self-reported an inappropriate posture. In

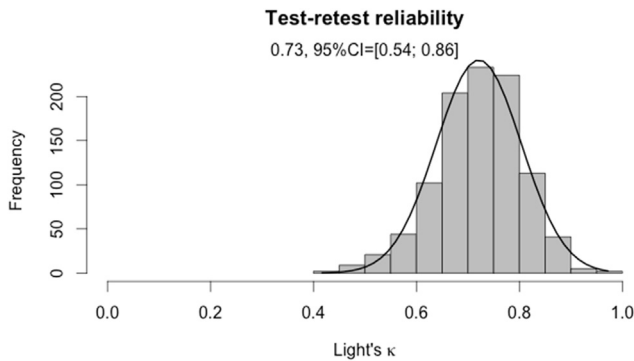


Fig. 3. Test–retest reliability (κ coefficient) of the self-perception of the neck posture during mobile phone use.

addition, the majority of the participants of this study had concerns about their posture. These findings raise the hypothesis that most people have a negative belief about their own posture. There is evidence that the ‘straighten your back’ command used by parents leads to moving the spine away from the mid-range towards the end range of motion in children (Czaprowski et al., 2014). Moreover, the behaviour of self-correcting one’s own posture frequently could be considered as hypervigilance and could contribute to a more sensitised central nervous system.

The assessment of the self-perception of posture during mobile phone texting using illustrations was an attempt to understand what participants think about their own posture. This approach has been used in a previous study about the association between home posture habits and low back and neck pain (Meziat Filho and Coutinho, 2015, 2016a,b). In the present study, since none of the participants chose the response ‘I don’t know’, we recommend the exclusion of the fifth response option.

Taking into account the variability of the subjective photographic analysis, we decided to define the *physiotherapists’ judgment* as the absolute agreement of two of the raters. Therefore, the accuracy analysis compared what the participants think about their own postures to the opinion of the physiotherapists. Since the prevalence of neck pain and mobile phone use for texting have been growing together, the new villain is the bad posture while texting on mobile phones. This concern has been spread in the media without the support of any scientific evidence. Therefore, it is necessary to investigate the relationship between *text neck* and neck pain.

A high proportion of the participants reported more than 4 h of mobile phone use per day. Lin et al. (2015) showed that people have

a tendency to underestimate their mobile phone use when comparing the self-report to the assessment by a mobile application in young adults. Nevertheless, Christensen et al. (2016) assessed the screen time through a mobile application and found a mean screen time over 30 days of only 3.7 min per hour, which is lower than our findings, but the mean age was higher.

To our knowledge, this was the first study to test the reliability and validity of the self-perception of the posture during mobile phone texting. It is important to develop pragmatic tools to assess the posture during texting on mobile phones in epidemiological studies. Gustafsson et al. (2017) found a cross-sectional association between text messaging and neck and shoulder pain. In the same study, although texting did not increase the risk of new episodes of neck pain, it was associated with the persistence of neck symptoms in the follow-up. However, this study did not assess the type of posture adopted during mobile phone texting.

Our findings should be interpreted within certain limitations. As participants previously knew about the aim of the study, they might have been intentionally or unintentionally using a better posture than typical for them during the posture assessment. This could partially explain the differences between their written responses and the photographic analyses. Although we have not assessed whether the visual impairments were regarding near-sightedness or farsightedness and the proportion of participants with uncorrected visual impairments during the assessment was high, this issue did not seem to influence the posture while texting on the cell phone. Also, the *self-perception* and *physiotherapists’ judgment* are probably different constructs. Although we performed an accuracy analysis possibly with two distinct constructs, and the reference test cannot be considered a gold standard, this method was the most appropriate to compare the participants’ opinion to the *physiotherapists’ judgment* about the posture. Nevertheless, the opinion of three experienced physiotherapists about posture was an attempt to reproduce an assessment in the clinical setting. Another possible, but less pragmatic, assessment option would be the photographic method to assess the sagittal head and cervical postures by head tilt angle, neck tilt angle, forward head shift, and gaze angle (Guan et al., 2015). Future studies should also include photographic analysis of the sitting posture during mobile phone texting.

5. Conclusion

This study showed that the self-perception of the neck posture during mobile phone texting is reliable over time and that the physiotherapists’ classification based on photographic analysis was acceptable for epidemiological studies. Participants had a tendency to report that their posture was worse than it actually was in the photographic analysis performed by the physiotherapist.

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References

- Christensen, M.A., Bettencourt, L., Kaye, L., Moturu, S.T., Nguyen, K.T., Olgin, J.E., et al., 2016. Direct measurements of smartphone screen-time: relationships with demographics and sleep, 11 PLoS One (11), e0165331. Available from: <http://dx.plos.org/10.1371/journal.pone.0165331>.
- Czaprowski, D., Pawłowska, P., Stoliński, L., Kotwicki, T., 2014. Active self-correction of back posture in children instructed with “straighten your back” command. Man. Ther. 19 (5), 392–398. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24246905>.
- Fejer, R., Kyvik, K.O., Hartvigsen, J., 2006. The prevalence of neck pain in the world

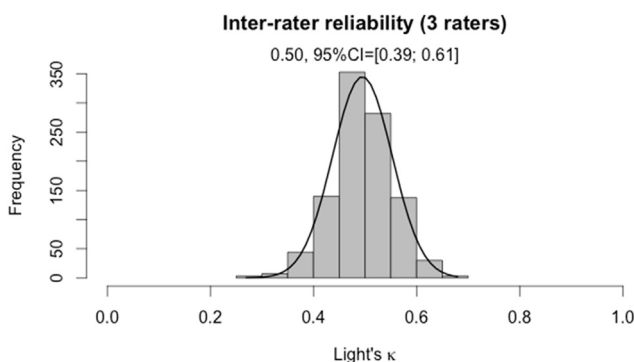


Fig. 4. Inter-rater reliability (κ coefficient) of the photographic analysis of the neck posture during mobile phone use.

- population: a systematic critical review of the literature. *Eur. Spine J.* 15 (6), 834–848. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3489448&tool=pmcentrez&rendertype=abstract>.
- Guan, X., Fan, G., Wu, X., Zeng, Y., Su, H., Gu, G., et al., 2015. Photographic measurement of head and cervical posture when viewing mobile phone: a pilot study. *Eur. Spine J.* 24 (12), 2892–2898. Available from: <http://link.springer.com/10.1007/s00586-015-4143-3>.
- Gustafsson, E., 2012. Ergonomic recommendations when texting on mobile phones. *Work* 41 (Suppl. 1), 5705–5706. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22317659>.
- Gustafsson, E., Johnson, P.W., Lindegård, A., Hagberg, M., 2011. Technique, muscle activity and kinematic differences in young adults texting on mobile phones. *Ergonomics* 54 (5), 477–487. Available from: <http://www.tandfonline.com/doi/abs/10.1080/00140139.2011.568634>.
- Gustafsson, E., Thomée, S., Grimby-Ekman, A., Hagberg, M., 2017. Texting on mobile phones and musculoskeletal disorders in young adults: a five-year cohort study. *Appl. Ergon.* 58, 208–214. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0003687016301235>.
- Hakala, P., Rimpelä, A., Salminen, J.J., Virtanen, S.M., Rimpelä, M., 2002. Back, neck, and shoulder pain in Finnish adolescents: national cross sectional surveys. *BMJ* 325 (7367), 743. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=128374&tool=pmcentrez&rendertype=abstract>.
- Hansraj, K.K., 2014. Assessment of stresses in the cervical spine caused by posture and position of the head. *Surg. Technol. Int.* 25, 277–279. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25393825>.
- Hoy, D.G., Smith, E., Cross, M., Sanchez-Riera, L., Buchbinder, R., Blyth, F.M., et al., 2014a. The global burden of musculoskeletal conditions for 2010: an overview of methods. *Ann. Rheum. Dis.* 73 (6), 982–989. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24550172>.
- Hoy, D., March, L., Woolf, A., Blyth, F., Brooks, P., Smith, E., et al., 2014b. The global burden of neck pain: estimates from the Global Burden of Disease 2010 study. *Ann. Rheum. Dis.* 73 (7), 1309–1315. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24482302>.
- IBGE. National Household Survey, PNAD. Brazilian Inst Geogr Stat 2016, 2011. Korpinen I, paakkonen r. Physical symptoms in young adults and their use of different computers and mobile phones. *Int. J. Occup. Saf. Ergon.* 17 (4), 361–371.
- Kottner, J., Audigé, L., Brorson, S., Donner, A., Gajewski, B.J., Hróbjartsson, A., et al., 2011. Guidelines for reporting reliability and agreement studies (GRRAS) were proposed. *J. Clin. Epidemiol.* 64 (1), 96–106. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21130355>.
- Landis, J.R., Koch, G.G., 1977. The measurement of observer agreement for categorical data. *Biometrics* 33 (1), 159–174. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/843571>.
- Lin, Y.-H., Lin, Y.-C., Lee, Y.-H., Lin, P.-H., Lin, S.-H., Chang, L.-R., et al., 2015. Time distortion associated with smartphone addiction: identifying smartphone addiction via a mobile application (App). *J. Psychiatr. Res.* 65, 139–145. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0022395615001004>.
- McGee, S., 2002. Simplifying likelihood ratios. *J. Gen. Intern. Med.* 17 (8), 646–649. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12213147>.
- Meziat Filho, N., Azevedo e Silva, G., Coutinho, E.S., Mendonça, R., Santos, V., 2016a. Association between home posture habits and neck pain in High School adolescents. *J. Back Musculoskelet. Rehabil.* <https://doi.org/10.3233/BMR-150339>.
- Meziat Filho, N., Coutinho, E.S., 2015. Azevedo e Silva G. Association between home posture habits and low back pain in high school adolescents. *Eur. Spine J.* 24 (3), 425–433. Available from: <http://link.springer.com/10.1007/s00586-014-3571-9>.
- Meziat-Filho, N., Mendonça, R., Pezolato, A., Reis, F.J.J., Calazans Nogueira, L.A., 2016b. Reproducibility of the low back clinical postural grouping in adolescents. *J. Bodyw. Mov. Ther.* 20 (2), 265–269. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27210842>.
- Myrtveit, S.M., Sivertsen, B., Skogen, J.C., Frostholm, L., Stormark, K.M., Hysing, M., 2014. Adolescent neck and shoulder pain—the association with depression, physical activity, screen-based activities, and use of health care services. *J. Adolesc. Health* 55 (3), 366–372. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24746679>.
- Nordicom, 2010. The Swedish media barometer 2009. Univ gothenbg nord inf cent media commun res..
- Seah, S.H.H., Briggs, A.M., O'Sullivan, P.B., Smith, A.J., Burnett, A.F., Straker, L.M., 2011. An exploration of familial associations in spinal posture defined using a clinical grouping method. *Man. Ther.* 16 (5), 501–509. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21641850>.
- Ståhl, M.K., El-Metwally, A.A.S., Rimpelä, A.H., 2014. Time trends in single versus concomitant neck and back pain in Finnish adolescents: results from national cross-sectional surveys from 1991 to 2011. *BMC Musculoskel. Disord.* 15, 296. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4161855&tool=pmcentrez&rendertype=abstract>.