An investigation of the reliability of Rapid Upper Limb Assessment (RULA) as a method of assessment of children’s computing posture

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**ABSTRACT**

Rapid Upper Limb Assessment (RULA) is a quick observation method of posture analysis. RULA has been used to assess children’s computer-related posture, but the reliability of RULA on a paediatric population has not been established. The purpose of this study was to investigate the inter-rater and intra-rater reliability of the use of RULA with children. Video recordings of 24 school children were independently viewed by six trained raters who assessed their postures using RULA, on two separate occasions. RULA demonstrated higher intra-rater reliability than inter-rater reliability although both were moderate to good. RULA was more reliable when used for assessing the older children (8–12 years) than with the younger children (4–7 years). RULA may prove useful as part of an ergonomic assessment, but its level of reliability warrants caution for its sole use when assessing children, and in particular, younger children.

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1. Introduction

Studies have shown that computer-related activities are risk factors for musculoskeletal pain among adolescents (Hakala et al., 2006), and more recently a U-shaped relationship between internet use and adolescent health has been established (Bélanger et al., 2011). With increasing numbers of children using computers daily it is important to assess the impact of that use on their posture as they may be at risk of developing computer-related musculoskeletal disorders. Methods of assessment of children’s posture during computer use described in the literature include Rapid Upper Limb Assessment (Oates et al., 1998; Laeser et al., 1998; Breen et al., 2007; Kelly et al., 2009) and 3D Motion Analysis Systems (Straker et al., 2002; Briggs et al., 2004; Maslen and Straker, 2009).

1.1. Rapid Upper Limb Assessment

Rapid Upper Limb Assessment (RULA) is a subjective observation method of posture analysis that focuses on the upper body, but includes the lower body. It uses a series of illustrations of different body postures, as shown in Fig. 1, and a numerical score is allocated to the most common observed posture (McAtamney and Corlett, 1992). Group A consists of the upper arm, lower arm and wrist, and group B consists of the neck, trunk and legs. The score for group A postures and group B postures and the scores for static muscle work and force are added as appropriate to give a C score (upper limb) and a D score (neck, trunk and legs). The C and D scores are then combined in a table to give a Grand Score. The Grand Score is used to assign the observed posture into an Action Level that indicates the required intervention (Table 1). RULA was developed as a screening tool for exposure of adults to risk factors for work-related upper limb disorders, and takes into account the repetitive movements and force that may be required for a task. It was designed to be carried out quickly and with minimal equipment or change to the working environment, and with minimal disruption to those under observation. It requires no previous skills in observation techniques and is easy to learn. RULA has previously been shown to be reliable with adults (McAtamney and Corlett, 1993).

Statistical calculations were not published but the authors state that the scores indicated a high consistency among assessors. RULA has also been used to assess children’s posture, but there are no studies looking particularly at the reliability of RULA with children. Laeser et al. (1998) established the reliability of RULA prior to their study, which analysed the effects of computer workstation layout on children’s posture (11–15 years). An external group of observers rated four videotaped postures and compared the ratings with the lead investigator’s scores. RULA was found to be reliable (Pearson’s $r = 0.96, p = 0.039$). Other studies that have also alluded to the reliability of RULA include Breen et al. (2007) who found $r = 0.946$ when used to assess 9–10 year olds and
Oates et al. (1998) who cited the main observer's reliability using RULA as $r = 0.73$ when assessing 8.5–11.5 year olds. Although these studies have sought to test inter-rater reliability as a preliminary part of a study, none had focussed specifically on the reliability of RULA with children. The aim of this study was therefore to investigate the inter-rater and intra-rater reliability of RULA when used to assess the posture of children aged 4–12 years. The objectives were: 1) to establish the inter-rater reliability of RULA in children, 2) to establish the intra-rater reliability of RULA in children, and 3) to investigate the association, if any, between child's age and reliability of RULA.

2. Methods

2.1. Study design

The first phase of the study was school-based and involved the collection of video footage of primary school children as they worked at computers in school during normal school hours and in usual working conditions. This was to improve external validity. The second phase of the study was laboratory-based with undergraduate physiotherapy students and experienced physiotherapists using RULA to assess the posture of the children in the video clips.

2.2. Sample size

Calculations were made to establish the required sample size of three raters using a one-way Anova formula as suggested by Walter et al. (1998). The required number of video clips was twenty-four, in order to achieve a power of 80% and two-sided level of significance ($p < 0.05$) to detect an ICC of 0.6 or greater, which is a moderate level of reliability.

2.3. Procedure

The school principal was contacted by telephone to request a meeting to discuss the feasibility of doing the study in his school. Following the meeting the principal was given envelopes containing participant information leaflets, consent and assent (for children who were 7 years and older) forms for distribution to potential participants. Parents/guardians of the children were requested to return completed consent and assent forms as appropriate to the class teacher in the self-addressed envelope provided. A period of seven days was allowed between distribution and collection of the consent and assent forms. The participants and their parents were aware that the study involved the assessment of children's computing posture. Three children chosen by the principal from each of the eight classes in the school were included in the study. The only request from the researchers was that the principal should include at least one girl and one boy from each class to ensure that there was no gender bias in the sample.

2.4. Measures

Data collection commenced once consent and assent were given. Children were filmed in the computer room in their class groups i.e. in groups of three. The children sat at a computer workstation to work on an assignment given to them by the teacher who was also present in the computer room. Each child was filmed using a Sony Handycam DCR–SR52E for approximately 2 min once they were engrossed in a task. The videographer was seated on a chair with castors to facilitate ease of movement from the lateral to the posterior aspects within the same film clip. It also allowed the camera to be level with the seated children rather than distorting the angle by filming from above. Filming started from the lateral aspect on the right hand side of the child, irrespective of the child’s hand dominance, panned around to the posterior aspect of the child and then back to the lateral aspect again.

Video files were converted to mpeg-4 for editing purposes, and the children's faces were blurred. The video files were exported to digital video disc (DVD) studio where DVD menus were authored enabling individual clip play or playing of the entire sequence of clips. All of the individual clips were randomised over each of the three different DVDs with three different clip order sequences to reduce the learning or memory effects between sessions. Individual clips were named alphabetically. A training DVD with three clips, different from those used in the main study, was also authored. Four DVDs were burned in total.

2.5. Raters

2.5.1. Physiotherapy students

An email was sent to all undergraduate physiotherapy students in Trinity College Dublin (TCD) at the time of the study inviting...