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Original article

Ageing and obesity indices influences the tactile acuity of the low back regions: A cross-sectional study☆

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ABSTRACT

Background and aims: Two-point discrimination threshold (TPDT) is increased in individuals with chronic low back pain. TPDT reference values and their determinants are required for clinical applications. Therefore, the aims of this research are to establish reference values for TPDT of the low back regions in healthy individuals, stratified for age, and to investigate the associations of demographic and anthropomorphic variables with TPDT.

Methods: Healthy individuals (n = 79) across four decades (Group-I:18–29; Group-II:30–39; Group-III:40–49; and Group-IV:50–59years) were recruited. A mechanical calliper tool was used to determine the low back TPDT (mm) using an adaptive staircase method. Descriptive statistics were calculated for TPDT for each age group. Paired t-tests ($p \leq 0.05$) were used to assess within group differences in TPDT between body sides. Univariate and weighted least squared linear regression analyses were performed to investigate associations between TPDT estimates and demographics, and body mass index (BMI), waist hip ratio (WHR).

Results: Mean (SD) age = 38.3(12.2); 55 female; and 73 right lower limb dominant. Mean (SD) TPDT threshold for all age groups: right = 67.3(15.6), and left = 65.7(15.4). No significant differences between left and right sides of the low back except in group-IV (mean difference:5.6[0.7–10.5]; P = 0.028). A total of 18% of TPDT variance (adjusted $R^2 = 0.183$; $\beta = 0.6$; $p = \leq 0.001$) of low back regions was explained by age with BMI and WHR weighted independently.

Conclusions: Age, BMI, and WHR were independently associated with TPDT of the low back, and the influence of age was significantly influenced by obesity indices.

1. Introduction

Two-point discrimination (TPD) describes a function of touch known as tactile spatial acuity (Jerosch-Herold, 2005). As the ability to discriminate one from two points of light touch extends beyond simple touch detection, TPD represents a function of touch that includes significant central and peripheral neural mechanisms (Tamura et al., 2003). The significance of central mechanisms defining TPD have been well-established in the literature (Moberg, 1991; Weinstein, 1993), with recent research demonstrating that somatosensory cortex responses are a greater indication for TPD ability compared to peripheral components (Tamura et al., 2003; Pleger et al., 2006). Acknowledgement of the predominant cortical processes involved in TPD has expanded the clinical utility of TPD assessments beyond investigating peripheral nerve function (Catley et al., 2013).

Chronic pain associated with musculoskeletal conditions, such as chronic low back pain, is accompanied by changes to the anatomical representation of the affected body part in the somatosensory cortex (Kong et al., 2013; Catley et al., 2014). Electrophysiological studies have demonstrated that these structural changes correlate with altered two-point discrimination threshold (TPDT) of the painful body regions (Flor et al., 1997; Pleger et al., 2006; Gwilym et al., 2010). Recent evidence has specifically indicated increases in low back TPD thresholds in individuals with chronic low back pain (Peters and Schmidt, 1991; Moseley, 2008; Luomajoki and Moseley, 2011). Therefore, TPDT (a measure of tactile acuity) is used as a clinical signatory measure of somatosensory reorganization in conditions where the peripheral nervous system is less likely affected (Catley et al., 2013; Stanton et al., 2013).

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Although several studies have produced estimates of TPDT for areas of high functional acuity, such as the hand and face, minimal studies have explored areas of lower acuity, such as the back (Wand et al., 2014). In order to identify abnormal thresholds clinically, relevant reference values must be established for each region. Previous studies investigating TPDT of low back regions were comprised of small sample sizes, not stratified by age, and they only assessed unilateral sides of the back (Nolan, 1985; Luomajoki and Moseley 2011; Wand et al., 2014). However, in order to differentiate normal TPDT variability from abnormal thresholds in symptomatic populations or from the symptomatic side, development of area specific reference values is required (Wand et al., 2014).

Studies have identified individual factors influencing TPDT of body regions, such as the hands and face, to include: age, gender, limb dominance, and makers for obesity (Nolan, 1983; Boles and Givens, 2011; Bowden and McNulty, 2013). For example, some study results demonstrated regional gender differences which favoured women for increased TPDT ability (Nolan, 1985; Davey et al., 2001). Conversely, other studies which examined TPDT of multiple body regions found that women did not demonstrate greater TPDT ability of all tested body regions (Davey et al., 2001). Similar to gender, inconsistent reports of age associations suggest limited understanding of age effects on different body regions (Shimokata and Kuzuya, 1995; Bowden and McNulty, 2013). Furthermore, when examining the influence of limb dominance on TPDT, thresholds of unilateral sides of the body were associated with the dominant upper limb (Nolan, 1985; Catley et al., 2013). This lack of evidence regarding definitive conclusions on the influence of demographics and anthropometric variables on TPDT thresholds of the low back indicates the need for research which establishes reference values.

Thus, the aims of this study are to establish TPDT reference values for the low back in healthy individuals and to investigate associations of demographic and anthropometric variables on TPDT, including: age, gender, limb dominance, side of body, and anthropometric measures including body mass index (BMI) and waist to hip ratio (WHR).

2. Methods

2.1. Study design, ethical approval, and consent

This is a cross-sectional study that included TPDT assessments of low back as well as knee regions. This study was granted ethical approval by the University of Otago Human Ethics Committee. Written consent to participate in the study was obtained. TPDT was measured bilaterally. Each site was assessed once, in a random testing order generated and counterbalanced by a web based sequencer (https://www.random.org/). Duration of testing for each participant was approximately 30 min.

2.2. Participants

A convenience sample of healthy individuals across four decades, aged 18–59 years, was recruited from the community. Participants were excluded if they reported: current pain in the back, history of back pain sufficient to restrict work or leisure activities within the last two years, neurological conditions or injuries, chronic pain conditions, surgery within the last two years, skin conditions, any medical condition that affects sensation, cognitive impairments, or pregnancy (including less than six months post-partum).

2.3. Development of assessment protocol

The assessment procedure components were adapted from the psychophysical testing literature (Watson and Pelli, 1983; Moseley et al., 1990; Moberg, 1991; Bell-Krotoski et al., 1993; Ehrenstein and Ehrenstein, 1999; Klein, 2001; Myles and Binseel, 2007; Ariga and Lleras, 2011; Backonja et al., 2013; Jogan and Stocker, 2014) on quantitative assessment testing methods, which include adaptive staircase method, (method of constant stimulus (MCS)), threshold estimation, stimulus magnitude standardization testing order (null stimulus randomization).

2.3.1. Pilot testing

Pilot testing was performed on healthy individuals ($n = 4$) in order for the tester to establish familiarization and consistency with the procedure.

2.4. Procedure

Demographic and anthropometric data were collected, including: age, gender, ethnicity, determination of lower limb dominance (Schneiders et al., 2010), and anthropometric measures (height, weight, waist and hip circumference) according to the American College of Sports Medicine Guidelines (Walter et al., 2010).

2.4.1. Test area and positioning

For TPDT assessment of the low back, participants were positioned in prone with a pillow placed under their abdomen (Catley et al., 2013). Bilateral low back thresholds were assessed horizontally, halfway between the spinous process of L3 and the iliac crests (Luomajoki and Moseley, 2011).

2.4.2. TPDT assessment procedure

TPDT was assessed using a commercially available mechanical caliper tool (Aesthesiometer – Model 16023, Lafayette Instrument®). The caliper was pressed against the skin with enough pressure for the participant to just appreciate the touch sensation (Moberg, 1991; Lundborg and Rosen, 2004). Response profile used during testing was a three-alternative forced choice method (Klein, 2001). Participants were instructed to respond if they distinctly felt “one” point, “two” points, or if they were “unsure” (Klein, 2001; Reiswich et al., 2012). Null stimulus of one caliper point was randomly given to decrease the chance of response bias. Multiple steps were taken to minimize neural adaptation and interference, including: slight alteration of trial position, measured in millimetres, around the standardized test site (Nolan, 1983, 1985; Klein, 2001); wiping the skin firmly after 3–4 trials to reduce interference of residual sensations from previous stimulus (Peters and Schmidt, 1991; Klein, 2001); providing inter-stimulus intervals of 5 s between each stimulus application (Peters and Schmidt, 1991); and providing participants additional brief rest periods (2–5 min).

Fig. 1 illustrates the psychophysical adaptive staircase method used to assess TPDT utilizing an up-down tracking rule, adapted from the literature, for a total of 12 reversals (Moseley et al., 1990; Stevens and Cruz, 1996; Klein, 2001; Wand et al., 2014). The tracking rule was verified during pilot testing and included testing increments measured in millimetres including: one increment decrease in trial distances following correct responses; and, a two increment increase in trial distances following incorrect responses. Responses of “unsure” were scored as incorrect and thereby resulted in a two increment increase of the subsequent trial distance (Reiswich et al., 2012). The first 6 reversals utilized 5 mm increments, and were intended to direct testing in the vicinity of TPDT (Stevens and Cruz, 1996). The last 6 reversals utilized 2 mm