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Self-reported knee pain and disability among healthy individuals: reference data and factors associated with the Knee injury and Osteoarthritis Outcome Score (KOOS) and KOOS-Child

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SUMMARY

Objective: To develop normative reference data for the Knee injury and Osteoarthritis Outcome Score (KOOS) and KOOS-Child, as well as investigate socio-demographic, psychological and physical factors associated with knee pain and disability among healthy adults.
Method: The KOOS or KOOS-Child (each containing five subscales) was administered to participants aged 8–101 years within the 1000 Norms Project, an observational study of 1000 self-reported healthy individuals. Self-efficacy, physical activity, body mass index (BMI), lower limb alignment, knee frontal plane projection angle (FPPA), knee range of motion (ROM), knee and hip strength, six-minute walk, 30-second chair stand and timed up and down stairs tests were collected. KOOS data were dichotomised using established cut-off scores and logistic regression analyses were conducted for each subscale.
Results: Socio-demographic characteristics were similar to the Australian population. Normative reference data were generated for children (8–17 years) and adults (18–101 years). Female adults were up to twice as likely to report knee pain, symptoms and sport/recreation (Sport/Rec) limitations compared to males ($P < .05$). Older age, lower self-efficacy, greater BMI, varus lower limb alignment, lower knee flexion ROM and lower hip external rotation (ER) strength were independently associated with knee pain and disability among adults.
Conclusions: Age- and gender-stratified reference data for the KOOS and KOOS-Child have been developed to guide interpretation of results in practice and research for individuals with knee disorders. Psychological and physical factors are linked with self-reported knee pain/disability among adults, and longitudinal studies to investigate causation are required.
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Introduction

Knee disorders affect individuals across the lifespan[1,2]. In order to monitor outcomes in clinical practice, and to establish evidence-based interventions, robust outcome measures are crucial. Patient-reported outcome measures (PROs) provide valuable information from the individual's perspective regarding symptoms and perceived functioning. For example, the Knee injury and Osteoarthritis Outcome Score[3] (KOOS) is widely used in practice and research to assess short- and long-term consequences of knee disorders[4]. A paediatric version (KOOS-Child)[5] is available and both instruments have sound psychometric properties[3,6].

When using PROs to assess self-reported outcomes, access to normative reference data is essential. Normative reference data enable comparisons with *normal* (or expected) values and therefore facilitate interpretation of results in a clinical context[7]. Reference data for the KOOS are particularly important as knee pain and disability varies with age and gender[8]. One study developed KOOS reference data for 539 adults[9], although data were only reported for four age groups. No reference data for the KOOS-Child are available.

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Furthermore, understanding the relationship between PROs and physical measures will inform future research developing interventions for knee disorders. Knee pain has been linked with knee extension and hip external rotation (ER) weakness[10,11], and knee-related disability with joint stiffness and malalignment[12,13]. Deeper investigation of psychological as well as physical factors could reveal potential therapy targets. Therefore, the primary aim of this study was to develop age- and gender-specific reference data for the KOOS and KOOS-Child in self-reported healthy children and adults. A secondary aim was to investigate socio-demographic, psychological and physical factors associated with knee pain and disability among adults.

Methods

Participants

The 1000 Norms Project is an observational study of 1000 healthy individuals aged 3–101 years, stratified by age and gender, recruited from January 2014 to September 2015[14]. Data for 900 participants aged 8–101 years are reported in this study as the KOOS instruments are valid for individuals aged 8+ years. A structured convenience sampling approach using a range of media was employed to recruit participants from the Greater Sydney metropolitan area through council, community groups, sporting groups and educational institutions.

Eligible participants were healthy by self-report and did not report any major physical disabilities. 'Healthy' was defined as having 'a state of adequate independence in daily activities'[15]. Potential participants were asked the following questions:

1. "Do you consider yourself healthy for your age?"
2. "Are you able to participate in normal daily activities with respect to your age?"

Individuals who responded "yes" to both questions were screened for the following exclusion criteria:

1. Inability to follow age-appropriate instructions in English;
2. Self-reported health conditions substantially affecting function, including: acute knee injury; infectious or inflammatory arthropathies; severe musculoskeletal disorders (e.g., end-stage osteoarthritis); joint arthroplasty; diabetes; malignant cancers; demyelinating/inflammatory/degenerative neurological conditions; pregnancy; severe cardiac/pulmonary disease; body mass index (BMI)$\geq$40 kg/m^2 (Class III obesity) or dependence on mobility aids[14].

Written consent was obtained for all participants and from the parent/guardian for participants <18 years. The study has been granted institutional ethical approval (HREC 2013/640).

Self-reported ethnicity was collected per the Australian Standard Classification of Cultural and Ethnic Groups[16]. Ethnicity was classified into one of three groups using country of birth and self-reported ethnicity: British/European, Aboriginal/Torres Strait Islander or 'other' (Asian/American/African/Middle-Eastern). Socio-economic status was assessed using the Socio-Economic Indexes for Areas allocating a percentile score from 1 (most disadvantaged) to 100 (most advantaged) for Australian residential postcodes[17].

Self-reported measures

Knee pain and disability

The KOOS LK1.0[3] (18–101 years) and KOOS-Child[5] (8–17 years) were administered. The KOOS has 42 items across five subscales: knee pain (*Pain*), other symptoms (*Symptoms*), activities of daily living (*ADL*), function in sport and recreation (*Sport/Rec*) and knee-related quality of life (*QOL*). The KOOS-Child has 39 items across the same subscales, except *Sport/Rec* is labelled *Sport/Play*. This subscale is described herein as *Sport/Rec* for all participants. Both questionnaires have demonstrated construct and content validity as well as good-to-excellent test–retest reliability (KOOS $ICC_{2,1}$ = .75–.93, KOOS-Child $ICC_{2,1}$ = .78–.91)[3,6,18]. Subscale scores and a composite score using the average of the five subscales ($KOOS_5$) were calculated from 0 (worst) to 100 (best)[19]. Data were managed according to the instructions provided by the KOOS authors[3].

Other

Self-reported physical activity level was assessed using the International Physical Activity Questionnaire-long form[20] (18–69 years) or elderly version (70–101 years)[21]. Categorical scores were re-coded to indicate 'low/moderate' or 'high' physical activity. Self-efficacy was measured using the eight-item New General Self-Efficacy Scale (18–101 years), scored from 5 (lowest) to 40 (best)[22].

Physical measures

Physical measures were collected using a standardised protocol[14]. Height, weight and BMI were measured. Lower limb alignment, dynamic knee control using knee frontal plane projection angle (FPPA), knee range of motion (ROM) and hip and knee strength were assessed on the dominant lower limb. Lower limb alignment was measured indirectly using a digital inclinometer fixed to medical calipers held at the midpoints of the patella and ankle joint to measure tibial angle (negative angle = valgus)[23]. For knee FPPA, markers were placed on the anterior superior iliac spine and the midpoints of the patella and ankle joint. Participants performed five single-leg mini squats with support in front of a high-definition video camera. The tibiofemoral angle was calculated at the deepest point of the squat (approximately 50° knee flexion) using 2-dimensional video analysis software (Kinovea 0.8.15) (negative angle = valgus)[24]. The average of five trials was recorded ($ICC_{2,1}$ = .99). Knee flexion and extension ROM were assessed in supine using goniometry, taking the mean of two trials. Hip ER strength was assessed in sitting using handheld dynamometry. For participants aged 12+ years, isometric knee flexion and extension strength were assessed at 60° knee flexion using fixed dynamometry (CSMi, HUMAC NORM, Stoughton, MA, US). The peak torque value of three maximal 5-s trials following one practice was recorded and averaged. For 8–11 year-old and for aged participants with conditions precluding fixed dynamometry (e.g., frailty), knee strength was measured using handheld dynamometry. Knee handheld dynamometry scores were transformed to Newton-metres using the participant's leg length[25]. All strength data were normalised to body mass.

Three performance-based measures recommended by Osteoarthritis Research Society International were collected: six-minute walk test, 30-second chair stand and timed up and down stairs[26]. The six-minute walk test assessed walking endurance, measuring the total distance while walking as quickly as possible for 6 min[27]. For the 30-second chair stand, the number of full sit-to-stands performed as quickly as possible in 30 s was recorded[28]. The timed up and down stairs test measured stair-climbing ability, recording the time taken to safely ascend and descend a flight of stairs[29]. Results for the six-minute walk and timed up and down stairs were scaled to leg length[30]. Physical tests were conducted by two experienced physiotherapists who demonstrated excellent inter-rater reliability ($ICC_{2,1}$ = .94–.98) in a pilot study (n = 10, age range = 6–67 years).

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