# Functional fitness for dental hygiene students: Does it make them fit to sit?

**Joanne L Parsons***, BMR(PT), MSc, PhD; **Laura MacDonald**[§], MEd, RDH; **Marielle Cayer**[†], MPT; **Mikaela Hoeppner**[†], MPT; **Ashley Titterton**[†], MPT; **Justin Willsie**[†], MPT; **Sandra C Webber**[Δ], BMR(PT), MSc, PhD

## WHY THIS ARTICLE IS IMPORTANT TO DENTAL HYGIENISTS

- Musculoskeletal disorders pose a significant risk to the well-being and career longevity of dental practitioners.
- Because work-related musculoskeletal disorders appear during training programs, functional fitness to improve postural awareness and physical fitness is important to include in dental hygiene curricula.
- After 12 weeks of functional fitness training, students improved in some core stability and postural tasks, and showed high levels of knowledge about and strong belief in the benefits of exercise.

## ABSTRACT

**Background:** Static positioning and awkward postures put dental hygienists at risk for work-related musculoskeletal disorders. These disorders often appear during professional training programs. Ergonomics education has been shown to reduce the incidence of injuries, but fitness training to improve postural awareness and endurance is not typically included in dental hygiene curricula. This study assessed the effects of a 12-week functional fitness training program on ergonomic and postural knowledge, outcome expectations and self-efficacy related to exercise, and core stability in final-year dental hygiene students. **Methods:** Participants (n = 24) completed surveys and core stability tests and demonstrated postural movements before and after completing a mandatory weekly training program focusing on dynamic core stabilization, aerobic exercise, and postural awareness. **Results:** Participants improved static plank hold time and left leg forward lunge scores, with no significant changes in right lunge or stability push-up tests. Accuracy in demonstrating postural movements in response to verbal cues improved for 2 of 6 movements. Knowledge about injury risk factors and body mechanics was relatively high at pre-test and did not change post-test. Outcome expectations and self-efficacy were not significantly different from pre- to post-test. **Conclusions:** Functional fitness training resulted in increased core endurance and improved execution of some movement patterns associated with good body mechanics. Our study provides evidence for the inclusion of this type of conditioning program in the dental hygiene curriculum. Further research, including more sensitive tests of physical function as well as the transfer of knowledge and safe postures into clinically relevant situations, is warranted.

## RÉSUMÉ

**Contexte :** Le positionnement statique et les mauvaises postures mettent les hygiénistes dentaires à risque de troubles musculosquelettiques liés au travail. Ces troubles surviennent souvent au cours des programmes de formation professionnelle. Il a été démontré que la formation en matière d'ergonomie réduit l'incidence des blessures, alors que le conditionnement physique effectué pour améliorer la prise de conscience posturale et l'endurance ne fait généralement pas partie du programme d'étude en hygiène dentaire. La présente recherche a évalué les effets d'un programme de conditionnement physique fonctionnel de 12 semaines sur les connaissances en matière de l'ergonomie et de la posture, des attentes de résultats, de la connaissance de ses propres capacités liées à l'exercice, ainsi que de la stabilité du tronc chez les étudiants de dernière année en hygiène dentaire. **Méthodologie :** Les participants (n = 24) ont rempli des sondages, effectué des tests de stabilité du tronc et démontré des mouvements posturaux avant et après avoir terminé une formation hebdomadaire obligatoire axée sur la stabilisation dynamique du tronc, les exercices aérobiques et la prise de conscience posturale. **Résultats :** Les participants ont amélioré leurs résultats de temps de planche statique et de l'exercice de fente avant de la jambe gauche et n'ont pas montré de changements significatifs dans leurs tests d'exercice de fente avant de la jambe droite ou de répulsions, des exercices de stabilisation du tronc. La précision des mouvements posturaux en réponse aux stimulations verbales s'est améliorée dans 2 des 6 mouvements. Les connaissances sur les facteurs de risque en matière des blessures et sur la mécanique du corps étaient relativement élevées au moment du test préliminaire et n'ont pas changé après le test. Les attentes de résultats et la connaissance de ses propres capacités n'étaient pas significativement différentes entre le test préliminaire et le post-test. **Conclusions :** Le conditionnement physique fonctionnel s'est traduit en une meilleure endurance du tronc et une performance améliorée de certaines séquences de mouvements associés à la bonne fonction mécanique du corps. Notre étude apporte des preuves qui appuient l'ajout de ce type de programme de conditionnement au programme d'hygiène dentaire. Il est justifié de faire des recherches plus poussées, y compris des évaluations plus sensibles de la fonction physique, ainsi que du transfert des connaissances et des postures sécuritaires aux situations cliniques pertinentes.

**Keywords:** body mechanics, core stabilization, curriculum, dental hygiene, physical activity, physical fitness, posture
**CDHA Research Agenda category:** capacity building of the profession

*Assistant professor, Department of Physical Therapy, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, MB, Canada
[§]Associate professor, School of Dental Hygiene, Dr. Gerald Niznick College of Dentistry, University of Manitoba, Winnipeg, MB, Canada
[†]Student (when the study was conducted), Department of Physical Therapy, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, MB, Canada
[Δ]Associate professor, Department of Physical Therapy, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, MB, Canada

Correspondence: Joanne L Parsons; joanne.parsons@umanitoba.ca
Manuscript submitted 11 December 2018; revised 4 June 2019; accepted 17 June 2019

## INTRODUCTION

Musculoskeletal disorders (MSDs) are common in the workplace and pose a significant risk to the well-being and career longevity of dental practitioners in particular.[1,2] Disorders can affect nerve, muscle, tendon or articular tissue, and are often concentrated in the upper extremities. The prevalence of pain associated with MSDs is extensive, ranging from 64% to 93% in a systematic review of dentists, dental students, and dental hygienists.[1] A greater number of dental hygienists than dentists report pain due to work tasks, with the highest disparity seen for hand pain (75% of dental hygienists versus 38% of dentists).[3] Elevated rates of neck and shoulder pain have also been reported by dental hygienists compared to dentists.[4] The impact on the workforce is significant; 18% of dental hygienists who permanently left clinical practice reported MSDs as the primary reason.[5]

Musculoskeletal disorders and pain manifest early, during training programs,[6-8] and it has been suggested that dental hygiene students experience MSDs at higher rates than students in other health professions.[7] A significant proportion (34% to 68%) of dental hygiene (DH) students report symptoms involving the wrist and hand, shoulder, neck, and upper and lower back over the duration of their training program.[7] Numbness is also found to increase as DH students progress through their studies, in concert with the number of hours they report using vibrating and manual instruments.[9] Similarly, rates of MSDs appear to rise as more time is accumulated in practice. DH students with no dental-related practice background reported lower rates of neck pain (37%) compared to DH students with prior experience as dental assistants (43%) and dental hygienists with at least 5 years of experience (72%).[10]

Risk factors for the development of MSDs in dental hygienists include long periods of static positioning and awkward postures, a confined field of work, forceful and repetitive work, the small size, shape, and vibration tendencies of their instruments,[2,11] and low levels of exercise.[6] Much attention is focused on working posture, as dental hygienists spend approximately 50% of their time in 30 degrees or more of trunk flexion, and 86% of their time in 30 degrees or more of neck flexion.[12] These sustained postures can lead to high strain and tissue overload, with increased potential for developing a MSD.[13] With these risk factors identified, numerous researchers have highlighted the need for early interventions to reduce MSDs in dental practitioners,[4,6,7,11] including embedding preventive ergonomics education into the curricula of dental programs.[4]

While dental hygiene programs recognize the importance of including ergonomics education in their curricula, data are limited on the extent of its delivery, and there is scant discussion about functional fitness as part of the curricula. A 1998 survey of American DH programs found the vast majority provided more than 10 hours of education on proper client/operator positioning and instrumentation technique.[14] One-third of the programs provided "additional" ergonomics education, most commonly on the topics of preventing MSDs and preventive exercise, but half of those programs devoted less than one hour to these topics.[14]

Among practising dental hygienists, those who received ergonomics education, which emphasizes the importance of client and operator positioning,[15] reported lower rates of MSDs.[16] A recent study found that ergonomic self-assessment training improved the posture scores of DH students, and a higher number of training sessions increased their ability to accurately evaluate their working posture.[17] Given that educating practitioners to be more aware of their body posture and function may reduce risk factors for MSDs, there has been increased interest in the role that physical fitness and exercise education can play in addressing these issues.[8]

Several authors have recommended exercise training that includes an abdominal/core stabilization component for practising dental professionals to prevent work-related MSDs.[18-20] However, there are few structured intervention studies on the specific effects of exercise training for this population, despite correlations between exercise habits and prevalence of pain,[3,6] and strong evidence that supervised programs including resistance training can be highly effective for controlling neck pain.[21] One study in which DH students participated in a yoga intervention twice per week found significantly lower overall and low back pain scores compared to a control group after 13 weeks, but no change in body composition.[22] Another study found that dental students who engaged in higher levels of physical activity and participated in a physical fitness course as part of their academic curriculum had lower rates of back pain.[8] However, this study did not include DH students, and the unsupervised course required only that the students engage in a minimum of 90 minutes per week of any physical activity, with a focus on aerobic sports.[8] In a survey of practising dental hygienists, those who reported using complementary therapies including yoga had significantly reduced pain levels.[23] However, yoga was the lone exercise-based therapy included in a list of 8 complementary therapies, and its individual effect was not examined. Another study found that a multifaceted program including "regular exercise" reduced rates of MSDs.[24] However, the participants in this study were practising dentists, all were male, and the exercise component consisted of only a few stretching exercises and the logging of any sports activities.

Intricately related to introducing and maintaining an exercise program are the notions that an individual's expectations and confidence to carry out the decisions and tasks needed to engage in the activity (self-efficacy) will ultimately influence whether the exercise behaviour is successful and sustained, or not.[25] No mention of these

concepts exists in any literature we are aware of related to the use of exercise training for the prevention of MSDs in dental practitioners.

Given the high prevalence of MSDs among dental hygienists, the early onset of symptoms during training programs, and the lack of information on the effects of embedding physical fitness and exercise education into the DH curriculum, this study aimed to assess knowledge, self-efficacy, outcome expectations, and physical competence regarding core stabilization, safe body mechanics, and exercise in DH students participating in weekly mandatory functional fitness classes over 12 weeks. The primary objectives were to assess changes in their knowledge of body mechanics; outcome expectations related to participating in functional fitness training; performance on physical tests requiring core stabilization; and ability to demonstrate postural movements taught in their functional fitness classes. The secondary objective was to assess the students' self-efficacy regarding participation in functional fitness activities.

## METHODS

### Research design and participants

The study was a quasi-experimental pre-post design involving a convenience sample of final-year DH students. All students who were capable of participating in the functional fitness classes (a requirement of their university program) were eligible to participate. This study was approved by the University of Manitoba Health Research Ethics Board.

### Study protocol

Data collection occurred on 3 occasions: one week prior to beginning fall semester functional fitness classes (pre), within one week of completing fall semester fitness classes (post), and then 10 months later when participants had completed the final semester of their university program (including another 12 weeks of functional fitness classes) and subsequently started working as dental hygienists (follow-up). In the pre- and post-training testing sessions, participants completed online questionnaires and underwent physical testing and an assessment of familiarity with postural cues; for the follow-up assessment, participants completed questionnaires only.

### Measures: Physical activity status, knowledge, outcome expectations, and self-efficacy related to engaging in core stabilization/functional fitness exercises

Participants completed online questionnaires at baseline to provide basic demographic information and establish their physical activity status (International Physical Activity Questionnaire [IPAQ] and participation in resistance training and core stabilization exercises),[26] and their knowledge of core stabilization and body mechanics principles (14 short-answer questions). Outcome expectations related to engaging in core stabilization/functional fitness exercises were determined through an analysis of answers to 13 questions. Participants rated their level of agreement with statements such as "Engaging in core stabilization/functional fitness will…1) increase the strength of core muscles, 2) strengthen my bones, 3) aid in weight control," etc. on a 5-point scale (from strongly disagree = 1 to strongly agree = 5).

The post-training questionnaire included the same knowledge and outcome expectations questions, as well as 5 questions about task self-efficacy related to the functional fitness classes (e.g., "How confident are you that…1) you were able to do the core stabilization/functional fitness exercises the way the instructor wanted them to be done, 2) you were able to see the relevance of doing the exercises as a student in dental hygiene, 3) the physical conditioning gained resulted in an improved ability to maintain good body mechanics in clinical situations," etc.). For these questions, participants rated their degree of confidence from 0 (not at all confident) to 100 (completely confident). Participants also completed 5 questions regarding their self-regulatory self-efficacy to continue to engage in core stabilization/functional fitness exercises (e.g., "How confident are you that you can…1) continue to engage in these types of exercises at least once per week, 2) do core stabilization/functional fitness exercises with proper technique, 3) set realistic goals for exercise, 4) anticipate problems that might interfere with continued exercise, and 5) develop solutions to problems that might interfere with continued exercise"). The follow-up questionnaire 10 months later included several questions about employment, the IPAQ,[26] and repeated the questions regarding outcome expectations and self-efficacy related to core stabilization/functional fitness exercise.

#### *Physical testing*

Participants' height and body mass were measured at baseline using a validated protocol.[27] Physical testing conducted pre- and post-training included the static plank hold,[28] in-line lunge test,[29] and trunk stability push-up.[30] All physical tests and postural movements were rated by trained physiotherapists and physiotherapy students using standardized rubrics.

A researcher demonstrated the positioning for the static plank hold (forearms and toes touching the ground)[28] and participants were given a 5-second practice trial with feedback about proper positioning. The practice trial was followed by a 15-second rest before the actual test repetition. For the test trial, participants were allowed one deviation from correct position, provided they corrected themselves immediately when prompted. The trial stopped when participants reached 2 minutes or when there was a second deviation from the proper position.[28]

The trunk stability push-up was assessed as outlined by Cook et al.[30] following an initial demonstration of the movement by a researcher (push-up from a prone position with feet together and hands placed under the

shoulders with fingers pointing forward). Participants were encouraged to attempt to lift their body as one solid unit, ensuring the chest and stomach came off the floor at the same time, with no adjustment of the initial hand position (for females the thumbs were aligned with the chin; for males the thumbs were aligned with the top of the forehead).[30] Participants had 2 practice trials and were given feedback on their form. After a 30-second rest, participants assumed the start position and attempted one push-up. If the attempt was unsuccessful, participants were given another 30-second rest and then attempted another push-up with their hands in an easier position (for females the thumbs were aligned with the clavicle, and for males the thumbs were aligned with the chin).[30] Participants were scored (1 to 3) based on the successful completion of the push-up.[30]

For the in-line lunge test, participants stood with their toes behind a marked starting point with a dowel held behind their back, in contact with their head and buttocks according to the protocol by Cook et al.[29] The movement (stepping forward and lowering the back knee to contact the ground before returning to the starting position) was demonstrated before participants attempted it. Participants were allowed 2 practice trials per leg, and up to 3 test trials on each leg. The front leg was scored following Cook et al.[29]

*Postural movement assessment*

Participants were asked to demonstrate postural movements in response to verbal cues. The cues were terms used regularly in their functional fitness classes (e.g., "engage your core muscles," "put your shoulder blades in your back pockets," "find lumbar neutral"). Postural movements were scored on a scale from 0 to 3, with 3 meaning that all required movement components were demonstrated and no extraneous movements were added; 2 meaning that the majority but not all required movement components were included; 1 meaning that less than 50% of required movement components were demonstrated; and 0 meaning that no attempt of the movement was made.

### Functional fitness training program

Participants attended weekly 50-minute functional movement training classes (a mandatory component of a theory/practice course in the DH curriculum) led by a certified fitness instructor. Each class consisted of 5 minutes of warm-up activities (e.g., dance aerobics, step aerobics, marching in place), 40 minutes of dynamic core stabilization and aerobic exercises (in lying, sitting or standing positions using resistance bands, dumbbells, exercise balls, steps, etc.) and 5 minutes of cool-down activities. The core stabilization challenge was increased over the 12 weeks. Physical and verbal cueing for all exercises ensured participants were conscious of lumbar and cervical neutral positions, "soft" joints, and core muscle engagement. The instructor and an assistant regularly walked among the participants to provide individualized feedback to ensure proper technique was followed.

### Data analysis

All statistical analyses were conducted using Microsoft Excel (Microsoft Corporation, Redmond, USA) and SigmaPlot (Systat Software Inc., Chicago, USA). Data were examined for normality using the Shapiro-Wilk test, and mean ± standard deviation (SD) or median (interquartile range [IQR]) were used to describe data as appropriate. Pre and post differences in knowledge, self-efficacy, physical tests, and postural movement scores were assessed using paired t-tests. Outcome expectations across all 3 time points were analysed using a one-way repeated measures analysis of variance. Relationships between participation in resistance training/core stabilization exercises and IPAQ category and physical performance at baseline were explored using Spearman's rank correlations. Statistical significance was set at $p \leq 0.05$.

## RESULTS

Twenty-four DH students (22 females, 2 males) completed pre- and post-testing. Nineteen students completed the follow-up questionnaire 10 months later. The average attendance at functional fitness classes was 11.8 ± 0.5 sessions over 12 weeks. Pre-training, 6 participants were rated as "high active," 11 as "minimally active," and 7 as "inactive" on the IPAQ.[26] Metabolic Equivalent (MET) minutes per week, measured with the IPAQ, did not change for the group from baseline to follow-up (1776 ± 1486 min versus 1692 ± 1500 min, $p = 0.87$). There were significant correlations between performance on the static plank hold test and self-reported minutes per week engaged in resistance training ($r_s = 0.78$, $p < 0.001$), minutes per week engaged in core stabilization exercises ($r_s = 0.73$, $p < 0.001$), and IPAQ category ($r_s = 0.48$, $p = 0.02$) at baseline. However, there were no significant relationships between resistance training/core stabilization minutes and the trunk stability push-up and in-line lunge tests. Eighteen of the nineteen participants reported being employed as a dental hygienist on the final follow-up questionnaire. They reported working for 1 to 4 months for 31.1 ± 9.6 hours/week. See Table 1 for a summary of baseline participant characteristics.

Knowledge of core stabilization and body mechanics concepts, outcome expectations of functional fitness participation, and self-efficacy regarding past and future exercise behaviour did not demonstrate significant change over time (Table 2). Participants improved on the static plank and left leg in-line lunge physical tests (Table 3). They significantly improved in accurately demonstrating "put your shoulder blades in your pockets" and "untuck your tail" (Table 4), 2 of the 6 postural movements.

**Table 1.** Baseline participant demographics

| Characteristic | Median (IQR) |
|---|---|
| Age (years) | 23 (5.5) |
| Mass (kg) | 59.2 (14.8) |
| Height (m) | 1.7 (0.1) |
| BMI (kg/m$^2$) | 21.9 (4.9) |
| Resistance training participation (min/week) | 2.0 (56.3) |
| Core training participation (min/week) | 0.0 (18.8) |

## DISCUSSION

Since MSDs often appear early in the career of a dental hygienist, embedding structured exercise sessions within dental hygiene curricula may encourage attention to posture and core stabilization during clinical work and everyday life and, therefore, prevent pain and disability. This study found that weekly participation in mandatory functional fitness classes led to some improvements in physical competence, but no changes in knowledge, outcome expectations or self-efficacy to engage in exercise.

### Physical activity knowledge and outcome expectations

Baseline scores for knowledge of principles of core stabilization and body mechanics and outcome expectations related to exercise were high, indicating that participants joined the study expecting numerous positive outcomes from exercise and with a good level of knowledge related to these topics. Data on how or where participants acquired their knowledge and expectations were not collected; they may have originated during previous years of education or from extracurricular activities such as other fitness classes or training. Regardless, it is encouraging that DH students are both coming into their final year and entering the workforce with a strong belief in the benefits of exercise, and good knowledge of ergonomic concepts.

### Physical testing

The amount of change in physical performance of the 3 core stabilization tests (static plank, in-line lunge and stability push-up) was variable. The static plank hold increased by a significant 23%, which may be partially due to the high degree of similarity between that outcome measure and plank exercises undertaken during the functional fitness classes. Increased muscular endurance, as demonstrated by the static plank hold, may have clinical relevance for dental practitioners, as they are frequently required to function in sustained positions. Further investigation in this area is warranted. Baseline median in-line lunge scores were already high (3/3), perhaps resulting in a ceiling effect. Leg dominance was not recorded, which could be an explanation for the fact that the left leg forward in-line lunge showed a statistically significant improvement, while the right leg forward in-line lunge score improved but did not reach significance. In this relatively small sample, there may have been a dominant stabilization pattern so that participants were more comfortable with their right leg forward. The stability push-up test may also have lacked the sensitivity to detect change. Individuals were scored as either being able to perform the push-up or not. The scoring system did not give credit for partial push-ups or for an increase in the height of the push-up attempt. Therefore, it is possible there were changes in strength that the scoring system was unable to detect.

Similar to normative data,[31] the scores on the in-line lunge were generally high, with very few participants scoring only 1 out of 3. For the trunk stability push-up, scores were lower than normative values. However, Schneiders et al. noted significant performance differences between males and females on this test, with the majority of males scoring 3, and the majority of females scoring 1.[31] The present study had only 2 male participants, which may account for the lower overall trunk stability push-up score.

Participants who reported engaging in more minutes per week of resistance training and core stabilization exercises, and/or were categorized as more active on the

**Table 2.** Questionnaire results[a]

| | Pre | Post | Follow-up | *p* value |
|---|---|---|---|---|
| Knowledge of core stabilization concepts (%) | 72.7 ± 14.4 | 74.3 ± 10.4 | N/A[b] | 0.58 |
| Outcome expectations of functional fitness classes (out of 65) | 57.4 ± 4.8 | 57.6 ± 4.4 | 56.3 ± 5.7 | 0.63 |
| Self-efficacy regarding past exercise behaviour (%) | N/A | 74.6 ± 13.7 | 66.5 ± 12.1 | 0.08 |
| Self-efficacy regarding future exercise behaviour (%) | N/A | 61.6 ± 17.5 | 66.3 ± 17.3 | 0.35 |

[a]Results are reported as mean ± standard deviation.
[b]N/A: not applicable; outcome not assessed at this time point.

**Table 3.** Physical test results[a]

| | Pre | Post | *p* value |
|---|---|---|---|
| Static plank (sec) | 64.3 ± 30.6 | 79.0 ± 29.4 | 0.02[b] |
| In-line lunge: left leg forward | 3 (1) | 3 (0) | 0.02[b] |
| In-line lunge: right leg forward | 3 (1) | 3 (0) | 0.07 |
| Stability push-up | 1 (1) | 1 (1) | 1.00 |

[a]Results are reported as mean ± standard deviation or median (interquartile range), as appropriate.
[b]Statistically significant at the $p \leq 0.05$ level.

IPAQ demonstrated better performance on the static plank hold test at baseline. This finding provides support for promoting exercise among dental hygiene professionals, as the improved core endurance may assist in better tolerance for work-related tasks that involve sustained, static positioning.

### Postural movement assessment

Scores for functional movements in response to verbal cues at baseline were generally low, which was expected, as the students had not yet been exposed to the functional fitness classes and the associated ergonomics language used. Statistically significant improvements from pre- to post-test were found for "place your shoulder blades in your pockets" and "untuck your tail." There were no changes for the other 4 movements. There may have been a ceiling effect for "engage your core," as only 3 of the 25 students scored less than a 3 at baseline. Prior to commencing our study, we confirmed the exact terminology used by the certified fitness instructor when leading the functional fitness classes. However, we did not assess the frequency of usage or whether the instructor was simply stating the terms rather than explaining them and their importance relative to DH occupational demands. Perhaps students were able to mimic the movements in class, but did not associate the movements with the terminology. Also unknown is the relationship between being able to reproduce the proper movements when cued, and the postures the participants hold in their activities as DH students. The inability to recreate specific movements does not necessarily translate to poor body mechanics.

### Self-efficacy related to engaging in core stabilization/ functional fitness exercises

Self-efficacy scores regarding future exercise behaviour were relatively low (61% to 66%) and reflect the challenge of maintaining a healthy behaviour given varied and often unfavourable genetic, physical, and social influences.[32] Although not significantly different, the scores on the 2 questions regarding clinical situations ("How confident are you that the knowledge gained from taking part in the exercise classes carried over and resulted in greater awareness of body mechanics in clinical situations?" and "How confident are you that the physical conditioning

**Table 4.** Postural cue results

| Postural cue | Pre Median (IQR) | Post Median (IQR) | *p* value |
|---|---|---|---|
| Hip hinge | 1 (1) | 1 (0.5) | 0.30 |
| Untuck tail | 1 (2) | 3 (1.5) | 0.01[a] |
| Find lumbar neutral | 1 (0) | 1 (0) | 1.00 |
| Float ears over shoulders | 1 (1) | 1 (2) | 0.17 |
| Engage core | 3 (0) | 3 (0) | 0.25 |
| Shoulder blades in pockets | 1 (1) | 2 (1.75) | 0.03[b] |

[a]Statistically significant at the $p \leq 0.01$ level
[b]Statistically significant at the $p \leq 0.05$ level

gained from taking part in the exercise classes resulted in an improved ability to maintain good body mechanics in clinical situations?") were noticeably lower at the 10-month follow-up compared to post-training (64% versus 78%; 57% versus 70%, respectively). These results may reflect the reality of working life as a dental hygienist. Six of the participants at follow-up reported working in more than one clinic; challenging physical environments are just one of the many known factors that influence behaviour change.[33] For example, the mobility of the clinical operatory (unit, chair, lighting, etc.) heavily influences body mechanics. In addition, dental hygienists who describe little decision-making involvement more commonly report MSDs.[16] It would be interesting to explore the degree of input that dental hygienists have on the ergonomic design of the operatory in their places of employment, as well as the influence that working in 2 or more settings has on the ability, desire, and will to employ good body mechanics.

### Strengths and limitations

The small sample size is one limitation of this study. In addition, the study did not control for all factors that may have affected physical performance on testing days, such as the length of time since previous exercise or the amount of sleep prior to testing. However, this study is unique in that it involves a curriculum-mandated, supervised functional fitness intervention developed specifically for the occupational needs of dental hygienists. The only previous study that examined a curriculum-based exercise intervention did not include dental hygienists and did not require the physical activities to have any particular structure or supervision, or to be relevant to the workplace demands of the profession.[8]

## CONCLUSION

Following 12 weeks of participation in mandated functional fitness classes, our cohort of DH students showed improvement in the static plank and left in-line lunge tests, and in demonstration of 2 of 6 postural movements. There was no change in their knowledge of principles of core stabilization and body mechanics, their outcome expectations relating to participation in fitness activities or their self-efficacy regarding past and future behaviour. Future studies should assess the extent to which functional fitness or structured exercise programs are incorporated into DH curricula in Canada and continue to examine the effects of these types of interventions on knowledge, physical fitness, and risk factors for MSDs in DH students. By delivering effective preventive education to students in the early stages of their professional programs, educators may improve the likelihood of their graduates enjoying a fulfilling, injury-free dental hygiene career.

## ACKNOWLEDGEMENTS

Funding for the study was provided by the University of Manitoba.

## CONFLICTS OF INTEREST

The authors are not aware of any existing or potential conflicts of interest.

## REFERENCES

1. Hayes M, Cockrell D, Smith DR. A systematic review of musculoskeletal disorders among dental professionals. *Int J Dent Hyg.* 2009;7(3):159–65.
2. Hayes MJ, Smith DR, Cockrell D. An international review of musculoskeletal disorders in the dental hygiene profession. *Int Dent J.* 2010;60(5):343–52.
3. Rucker LM, Sunell S. *Musculoskeletal health status in BC dentists and dental hygienists: Evaluating the preventive impact of surgical ergonomics training and surgical magnification.* Vancouver: Workers' Compensation Board of British Columbia; 2000.
4. Morse T, Bruneau H, Dussetschleger J. Musculoskeletal disorders of the neck and shoulder in the dental professions. *Work.* 2010;35(4):419–29.
5. Miller DL. An investigation into attrition of dental hygienists from the work force. *J Dent Hyg.* 1991;65(1):25–31.
6. Hayes MJ, Smith DR, Cockrell D. Prevalence and correlates of musculoskeletal disorders among Australian dental hygiene students. *Int J Dent Hyg.* 2009;7(3):176–81.
7. Hayes MJ, Smith DR, Taylor JA. Musculoskeletal disorders in a 3 year longitudinal cohort of dental hygiene students. *J Dent Hyg.* 2014;88(1):36–41.
8. Peros K, Vodanovic M, Mestrovic S, Rosin-Grget K, Valic M. Physical fitness course in the dental curriculum and prevention of low back pain. *J Dent Educ.* 2011;75(6):761–67.
9. Morse T, Michalak-Turcotte C, Atwood-Sanders M, et al. A pilot study of hand and arm musculoskeletal disorders in dental hygiene students. *J Dent Hyg.* 2003;77(3):173–79.
10. Morse T, Bruneau H, Michalak-Turcotte C, et al. Musculoskeletal disorders of the neck and shoulder in dental hygienists and dental hygiene students. *J Dent Hyg.* 2007;81(1):10.
11. Yamalik N. Musculoskeletal disorders (MSDs) and dental practice Part 2. Risk factors for dentistry, magnitude of the problem, prevention, and dental ergonomics. *Int Dent J.* 2007;57(1):45–54.
12. Marklin RW, Cherney K. Working postures of dentists and dental hygienists. *J Calif Dent Assoc.* 2005;33(2):133–36.
13. Noh H, Roh H. Approach of industrial physical therapy to assessment of the musculoskeletal system and ergonomic risk factors of the dental hygienist. *J Phys Ther Sci.* 2013;25(7):821–26.
14. Beach JC, DeBiase CB. Assessment of ergonomic education in dental hygiene curricula. *J Dent Educ.* 1998;62(6):421–25.
15. Smith CA, Sommerich CM, Mirka GA, George MC. An investigation of ergonomic interventions in dental hygiene work. *Appl Ergon.* 2002;33(2):175–84.

16. Hayes MJ, Taylor JA, Smith DR. Predictors of work-related musculoskeletal disorders among dental hygienists. *Int J Dent Hyg*. 2012;10(4):265–69.

17. Partido BB. Dental hygiene students' self-assessment of ergonomics utilizing photography. *J Dent Educ*. 2017;81(10):1194–202.

18. Kumar DK, Rathan N, Mohan S, Begum M, Prasad B, Prasad ERV. Exercise prescriptions to prevent musculoskeletal disorders in dentists. *J Clin Diagn Res*. 2014;8(7):ZE13–ZE16.

19. Jones AC, Forsythe S. Functional training for dentistry: An exercise prescription for dental health care personnel. *J Calif Dent Assoc*. 2005;33(2):137–45.

20. Valachi B, Valachi K. Preventing musculoskeletal disorders in clinical dentistry: Strategies to address the mechanisms leading to musculoskeletal disorders. *J Am Dent Assoc*. 2003;134(12):1604–612.

21. Coury HJCG, Moreira RFC, Dias NB. Evaluation of the effectiveness of workplace exercise in controlling neck, shoulder and low back pain: A systematic review. *Rev Bras Fisioter.* 2009;13:461–79.

22. Monson AL, Chismark AM, Cooper BR, Krenik-Matejcek TM. Effects of yoga on musculoskeletal pain. *J Dent Hyg.* 2017;91(2):15–22.

23. Chismark A, Asher G, Stein M, Tavoc T, Curran A. Use of complementary and alternative medicine for work–related pain correlates with career satisfaction among dental hygienists. *J Dent Hyg.* 2011;85(4):273–84.

24. Dehghan N, Aghilinejad M, Nassiri-Kashani MH, Amiri Z, Talebi A. The effect of a multifaceted ergonomic intervention program on reducing musculoskeletal disorders in dentists. *Med J Islam Repub Iran.* 2016;30:472.

25. Young M, Plotnikoff R, Collins C, Callister R, Morgan P. Social cognitive theory and physical activity: A systematic review and meta-analysis. *Obes Rev.* 2014;15(12):983–95.

26. International Physical Activity Questionnaire Short Last 7 Days Self-Administered Format [Internet]. 2012 [cited 2018 Dec 10]. Available from: https://sites.google.com/site/theipaq/questionnaire_links

27. Mirwald RL, Baxter-Jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sports Exerc*. 2002;34(4):689–94.

28. Boyer C, Tremblay M, Saunders TJ, et al. Feasibility, validity and reliability of the plank isometric hold as a field-based assessment of torso muscular endurance for children 8-12 years of age. *Pediatr Exerc Sci*. 2013;25(3):407–422.

29. Cook G, Burton L, Hoogenboom BJ, Voight M. Functional movement screening: The use of fundamental movements as an assessment of function—Part 1. *Int J Sports Phys Ther*. 2014;9(3):396–409.

30. Cook G, Burton L, Hoogenboom BJ, Voight M. Functional movement screening: The use of fundamental movements as an assessment of function—Part 2. *Int J Sports Phys Ther*. 2014;9(4):549–63.

31. Schneiders AG, Davidsson Å, Hörman E, Sullivan SJ. Functional movement screen normative values in a young, active population. *Int J Sports Phys Ther*. 2011;6(2):75–82.

32. Nahas MV, Goldfine B, Collins MA. Determinants of physical activity in adolescents and young adults: The basis for high school and college physical education to promote active lifestyles. *Phys Educat*. 2003;60(1):42–56.

33. Glanz K, Rimer BK, Viswanath K. Health behavior and health education: Theory, research, and practice. 4th ed. San Francisco (CA): Jossey-Bass; 2015.