Journal of Taibah University Medical Sciences (2024) 19(6), 1077–1084

Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com

Original Article

Manual dexterity characteristics throughout the menstrual cycle in healthy female dentists: An observational study

Amira I. Hassanein, MSc [a,*], Hala M. Hanfy, PhD [b], Hossam Al-Din H. Kamel, PhD [c] and Ahmed S. Shaban, PhD [a]

[a] *Department of Physical Therapy for Women's Health, Faculty of Physical Therapy, Horus University, Egypt*
[b] *Department of Physical Therapy for Women's Health, Faculty of Physical Therapy, Cairo University, Egypt*
[c] *Department of Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University, Egypt*

Received 12 July 2024; revised 5 October 2024; accepted 8 November 2024; Available online 17 November 2024

الملخص

أهداف البحث: تتعرض الإناث خلال الدورة الشهرية المنتظمة لتقلبات في المستويات الهرمونية، بما في ذلك هرموني الاستروجين والبروجستيرون. يقوم أطباء الأسنان غالبًا بحركات يد متكررة، مما يتطلب أن يكون لديهم مهارة يدوية عالية الكفاءة لإتقان إمساك الأدوات واستخدامها بمهارة. لقد أُقترح أن العوامل الهرمونية قد تؤثر على مستوى الأداء الوظيفي لطبيبات الأسنان، مما قد يزيد من احتمالية تعرضهن للإصابات العضلية الهيكلية مقارنةً بنظرائهن من الذكور. لذلك، أجريت هذه الدراسة لتقييم المهارة اليدوية وقوة قبضة اليد لدى طبيبات الأسنان أثناء المراحل المختلفة من الدورة الشهرية.

طرق البحث: شاركت خمس وأربعون طبيبة أسنان لديهن صحة جيدة ودورات شهرية منتظمة في هذه الدراسة. تراوحت أعمارهن ومؤشر كتلة الجسم من 25 إلى 35 عامًا ومن 18.5 إلى 24.9 كجم/م^2، على التوالي. تم تقييم مهارتهن اليدوية وقوة قبضتهن أثناء مراحل الحيض، التبويض، ومنتصف الطور الأصفري من الدورة الشهرية. تم تقييم المهارة اليدوية باستخدام المهام المتنوعة من اختبار لوح الربط بوردو لكل من اليد المهيمنة، اليد غير المهيمنة، كلتا اليدين، الإجمالي، والتجميعي. تم قياس قوة قبضة اليد لكل من اليد المهيمنة وغير المهيمنة باستخدام دينامومتر قبضة اليد.

النتائج: تم الحصول على قيم متوسطة أعلى ذات دلالة إحصائية في جميع مقاييس اختبار لوح الربط بوردو للمهارة اليدوية وقوة قبضة اليد أثناء مرحلة التبويض مقارنةً بمرحلتي الحيض ومنتصف الطور الأصفري. كما لوحظت قيمًا متوسطة أعلى ذات دلالة إحصائية في جميع مقاييس اختبار لوح الربط بوردو للمهارة اليدوية وقوة قبضة اليد أثناء مرحلة منتصف الطور الأصفري مقارنةً بمرحلة الحيض.

الاستنتاجات: تشير نتائج الدراسة إلى أن مرحلة الحيض قد تعيق كفاءة وظائف اليد الحركية مثل المهارة اليدوية وقوة قبضة اليد لدى طبيبات الأسنان، مما قد يزيد من احتمالية تعرضهن للاختلال الوظيفي في الجهاز العضلي الهيكلي في المستقبل.

الكلمات المفتاحية: طبيبات الأسنان؛ قوة قبضة اليد؛ البراعة اليدوية؛ الدورة الشهرية؛ اختبار بوردو للوتد

Abstract

Objectives: Throughout the regular menstrual cycle, women experience fluctuations in hormonal levels, including estrogen and progesterone. Dentists often perform repetitive hand movements requiring highly proficient manual dexterity to skillfully grip and manipulate tools. Hormonal factors have been suggested to influence female dentists' level of function, thus potentially making them more vulnerable to musculoskeletal injuries than their male counterparts. Therefore, this study was conducted to investigate female dentists' manual dexterity and handgrip strength (HGS) during different phases of the menstrual cycle.

Methods: Forty-five healthy female dentists with regular menstrual cycles participated in this study. Their ages and body mass index (BMI) were 25–35 years and 18.5–24.9 kg/m^2, respectively. The participants' manual dexterity and HGS were assessed during the menstrual, ovulation, and mid-luteal phases of the menstrual cycle. Manual dexterity was assessed with various measures of the Purdue Pegboard Test (PPT), including dominant hand,

* Corresponding address: Department of Physical Therapy for Women's Health, Faculty of Physical Therapy, Horus University, New Damietta, Egypt.
E-mail: ahassanein@horus.edu.eg (A.I. Hassanein)
Peer review under responsibility of Taibah University.

Production and hosting by Elsevier

 https://doi.org/10.1016/j.jtumed.2024.11.001

non-dominant hand, both hands, total, and assembly tasks. HGS for both dominant and non-dominant hands was measured with a handgrip dynamometer.

Results: Statistically significantly higher mean values ($P < 0.05$) were obtained for all measures of the PPT and HGS during the ovulation phase compared to the menstrual and mid-luteal phases. In addition, statistically significantly higher mean values ($P < 0.05$) were observed for all measures of the PPT and HGS during the mid-luteal phase compared to the menstrual phase.

Conclusions: The menstrual phase may hinder proficiency in hand motor functions, such as manual dexterity and HGS, in female dentists, thus potentially increasing their vulnerability to future musculoskeletal dysfunction.

Keywords: Female dentists; Handgrip strength; Manual dexterity; Menstrual cycle; Purdue Pegboard Test

Introduction

Dentistry is a medical profession in which ongoing innovation in materials requires dentists to continually develop their motor skills. Because of their occupation's physically and mentally demanding nature, which involves repeated hand movements and static loads while treating patients in a limited space, dentists must have a well-functioning musculoskeletal system.[1] Dentists generally require a high level of manual dexterity, grip strength, spatial perception, and the ability to maintain the proper ergonomic posture over extended periods. The dentistry profession combines art and science; therefore, dentists' hand function should be of a relatively high standard to maintain optimal performance during daily tasks.[2]

Manual dexterity, a crucial hand-functional property for dental professionals, is the ability to synchronize vision with hand and finger movements. It requires a high level of eye-hand coordination to skillfully and quickly move both hands together for various tasks, including gripping, placing, and manipulating objects. It is closely associated with handgrip strength (HGS), which serves as an objective indicator of upper extremity function. A decrease in HGS is predictive of future musculoskeletal disorders (MSDs).[2] The major risk factors for MSDs are female sex characteristics (57.1%), awkward work posture (50%), and being a dental specialist (42.9%). Female dentists are more susceptible than male dentists to upper body MSDs and may experience symptoms such as pain, numbness, and diminished ability to grip objects.[3,4]

Throughout their active reproductive years, women experience regular rhythmic physiological changes in their reproductive system every month, known as the menstrual cycle, which begins with the first day of menstruation and ends before the subsequent onset of menstrual bleeding. In eumenorrheic women, the menstrual cycle length usually ranges from 21 to 35 days, and the average length is 28 days. Across the menstrual cycle, substantial fluctuations are observed in the serum levels of the four main female sex hormones: estrogen, progesterone, follicle-stimulating hormone (FSH), and luteinizing hormone (LH). These hormonal fluctuations have key roles in regulating the menstrual cycle pattern, thus leading to two main phases, the follicular and luteal phases, which are separated by a shorter ovulation period.[5]

The normal menstrual cycle involves four distinct hormonal environments. The follicular phase is divided into two sub-phases: the early and late follicular phases. The early follicular phase is characterized by low estrogen and progesterone levels, whereas the late follicular phase is characterized by high estrogen and low progesterone levels, ending with the surge in LH levels that precedes ovulation. The ovulation phase is characterized by moderate estrogen and low progesterone levels. After LH has returned to basal levels, the luteal phase begins, with moderate estrogen and high progesterone levels in the mid-luteal phase.[5] Given that the receptors for estrogen and progesterone hormones are found in multiple tissues, such as bones, skeletal muscles, ligaments, and the nervous system, cyclical fluctuations in these hormones might influence the function of these tissues and biomechanical characteristics in women. This could potentially increase the risk of MSDs, leading to work absenteeism, loss of productivity, and long-term disability.[6]

To our knowledge, no previous studies have examined hand dexterity and HGS in healthy female dentists throughout the menstrual cycle. Given that hormonal fluctuations might influence muscle function and the nervous system,[6] we conducted this study to identify whether the menstrual cycle might affect manual dexterity and HGS in female dentists to provide deeper insights into the phase at which manual function proficiency might be affected. We hypothesized that female dentists' manual dexterity and HGS would not significantly fluctuate throughout the menstrual cycle.

Materials and Methods

Study design and settings

An observational study with a repeated measures design was conducted. Participants were assigned to a single group. The study was conducted at three menstrual cycle phases: the menstrual, ovulation, and mid-luteal phases. To control for the effects of repeated measures, the sequence of measurement phases was balanced among participants,[7] with one-third of participants starting the study during menstrual phase, one-third starting during ovulation phase, and one-third starting during mid-luteal phase. The study was conducted at the Horus University outpatient dental clinic in New Damietta City, Egypt, over a period of 6 months (July to December 2023).

Sample size estimation

A sample size calculation was performed in G*Power software (version 3.1.9.4, Franz Faul, Universität Kiel, Germany). The calculation considered F tests (multivariate analysis of variance [MANOVA]: repeated measures within factors), an alpha error of 0.05, a power of 0.8, and an effect size (d) of 0.316. The effect size was determined according to the results of the Purdue Pegboard Test (PPT) in a previous study conducted by Isik et al.[8] The initial estimated sample size was determined to be 36 participants. Considering a 20% sample dropout rate to ensure favorable power for significance, according to the formula ND = N/(1-d), we increased the total sample size (N) to 45 participants.

Participants' selection

A convenience sample of 45 female dentists was recruited through an advertisement posted on social networks and at the Horus University outpatient dental clinic. Participants were included after meeting the eligibility criteria outlined in the advertisement, including healthy female dentists with a regular menstrual cycle averaging 28 days in duration; ages of 25−35 years old; normal BMI values (18.5−24.9 kg/m^2); right-hand dominance; and at least 1 year of manual work experience. No participants had prior exposure to the PPT tasks, and they were blinded to the study hypothesis to prevent any potential learning effects.[7,9]

Female dentists were excluded from the current study if they had a history of menstrual irregularities, ovariectomies, hyperthyroidism, hyperandrogenemia, orthopedic or neurological conditions affecting hand function, muscle weakness, hand surgery, cerebrovascular diseases, psychiatric disorders, significant visual problems, or systemic conditions such as diabetes or hypertension. Pregnant and breastfeeding dentists, as well as those using hormonal therapy that might disrupt normal hormone levels, were also excluded from the study.[7,8]

Assessment procedures

Before conducting the study, detailed data regarding the participants' age, body weight, height, BMI, medical history, and menstrual cycle regularity were recorded in a datasheet. All participants provided written consent after understanding the objectives and procedures of the current study. They were also informed of their ability to discontinue the study at any time. After recruitment, participants were instructed to track their last three menstrual cycles with the Clue mobile application to accurately determine the menstrual cycle duration and the timing of the menstrual, ovulation, and mid-luteal phases.[10] Additionally, the exact ovulation timing was detected by measurement of the LH surge in the urine with urine LH strip tests (Shanghai International GmbH, Hamburg, Germany), starting on the 10th day of the menstrual cycle and continuing at approximately the same time of day until a positive test result was observed. After a positive urine LH strip test, ovulation was expected to occur within 24−36 h.[11]

Participants' manual dexterity and HGS were assessed in various menstrual cycle phases, coinciding with the 3rd or 4th day of the menstrual phase (excluding the 1st and 2nd days to prevent any potential confounding effects associated with the use of pain relievers or physical discomfort),[12] days 13−15 of the cycle (ovulation phase), and days 21−23 of the cycle (mid-luteal phase). Measurements were taken at the same time of day on every test occasion for each participant. Testing sessions were conducted in a quiet room to avoid distractions.[13] Participants were asked not to consume caffeine for 24 h before the testing sessions to avoid caffeine's ergogenic effects on hand muscles.[14]

Outcome measures

Manual dexterity performance (primary study outcome)

Participants' manual dexterity was assessed with the PPT device (Lafayette, Model 32020A, USA), which has excellent test-retest reliability and validity. The device set contains a rectangular plastic board with two columns of 25 holes each, along with four cups at the top, 55 pins, 25 collars, 45 washers, and score sheets. The rightmost and leftmost cups contain pins, whereas the two middle cups contain collars and washers. Because the participants were right-handed, the washers and collars were placed in the middle-left and middle-right-handed cups, respectively. The PPT includes four actual tasks—the dominant hand (DH), non-dominant hand (NDH), both hands (BH), and assembly tasks—and one mathematical sum calculation task, including the Purdue Pegboard total score, which is determined by combining the scores of the DH, NDH, and BH tasks. A higher score in each task indicates better manual dexterity.[15]

The PPT was chosen for the study to mimic dentists' typical work environment.[13] Participants were comfortably seated on a chair facing the Purdue Pegboard device positioned on a table. The tasks were first demonstrated, and participants were allowed to practice each task to gain familiarity. The participants were instructed to perform tasks as rapidly as possible, from the instruction to start to the instruction to stop. PPT tasks were performed in the following sequence: DH, NDH, BH, and assembly tasks.[15]

Dominant hand PPT

Participants were instructed to start by picking up pins with the right hand (only one pin at a time) from the right-side cup (corresponding to the right hand) and inserting them into the holes in the right-side column, beginning from the uppermost hole (Figure 1). After exactly 30 s, they were instructed to stop. The total number of pins successfully inserted in the right-side column was recorded. Participants performed this task three times. The average scores were calculated and were considered the participants' DH task scores.[15]

Non-dominant hand PPT

Participants were instructed to start by picking up pins with the left hand (only one pin at a time) from the left-side cup (corresponding to the left hand) and inserting them into the holes in the left-side column, beginning from the uppermost hole (Figure 2). After exactly 30 s, they were instructed to stop. The total number of pins successfully inserted in the left-side column was recorded. Participants performed this task three times. The average scores were calculated and were considered the participants' NDH task scores.[15]

Both hands PPT

Participants were instructed to start by picking up pins with both hands simultaneously from the right-side and left-side cups and inserting them in the two-sided holes, beginning with the top hole in each column (Figure 3). After exactly 30 s, they were instructed to stop. The total number of pin pairs successfully inserted (not the total count of pins) in the 30-s period were recorded. Participants performed this task three times. The average scores were calculated and were considered the participants' BH task scores.[15]

Assembly PPT

Participants were asked to start by taking one pin out of the right-side cup with the right hand and inserting it into the uppermost right-side hole. While inserting the pin, participants picked up one washer with the left hand and placed it over the pin. While placing the washer, participants picked up one collar with the right hand and placed it over the washer. While placing the collar, participants picked up another washer and placed it over the collar, and so on (Figure 4). After exactly 60 s, participants were asked to stop. The number of assembled components was counted. Each completed assembly was recorded as 4 points. Participants performed this task three times. The average scores were calculated and were considered the participants' assembly task scores.[15]

Handgrip strength (secondary study outcome)

Participants' HGS was measured for both the DH and NDH with a digital handgrip dynamometer (CAMRY, Model EH101, China), which has excellent reliability and validity. Before the assessment of HGS, the handle of the dynamometer was adjusted to the second handle position, which has been suggested to be the most reliable position, because it can help maximize HGS.[16] Participants were comfortably seated on a chair with back and arm supports. Their shoulders were adducted and neutrally rotated, their elbows were placed in 90° flexion, their forearms were supported in a mid-position, and their wrists were in a neutral position. They were instructed to squeeze the handle with maximum isometric effort, maintained for 3 s (Figures 5 and 6). To ensure accuracy, any other body movement or breath-holding was not allowed. Three trials were performed, with a 1-min rest in between to prevent fatigue. Trial scores were averaged for each hand and recorded in kilograms (kg).[2]

Statistical analysis

For data analysis, Statistical Package for the Social Sciences software (IBM SPSS, version 22 for Windows, Chicago, Illinois, USA) was used. Tables were generated in Microsoft Word. Before the final analysis, the Shapiro–Wilk test was performed and indicated that the data were normally distributed ($P > 0.05$). Descriptive statistics, including mean ± standard deviation (SD), were quantified for all variables. Parametric statistical analysis using one-way repeated measures MANOVA was conducted to analyze the outcomes of manual dexterity and HGS at the three measuring phases within the same group. Greenhouse-Geisser correction was applied, if necessary, to account for non-sphericity. Bonferroni's pairwise comparisons were applied to compare the results of outcome measures among the three measuring phases. The significance level was set at 0.05, with a P-value ≤ 0.05 indicating statistical significance.

Results

Participants' demographic characteristics

A total of 45 female dentists volunteered to participate in the study throughout their menstrual cycle phases. The mean ± SD values of the participants' demographic data are shown in Table 1.

Figure 1: Performance of the dominant hand Purdue Pegboard Test.

Figure 2: Performance of the non-dominant hand Purdue Pegboard Test.

Figure 3: Performance of the both hands Purdue Pegboard Test.

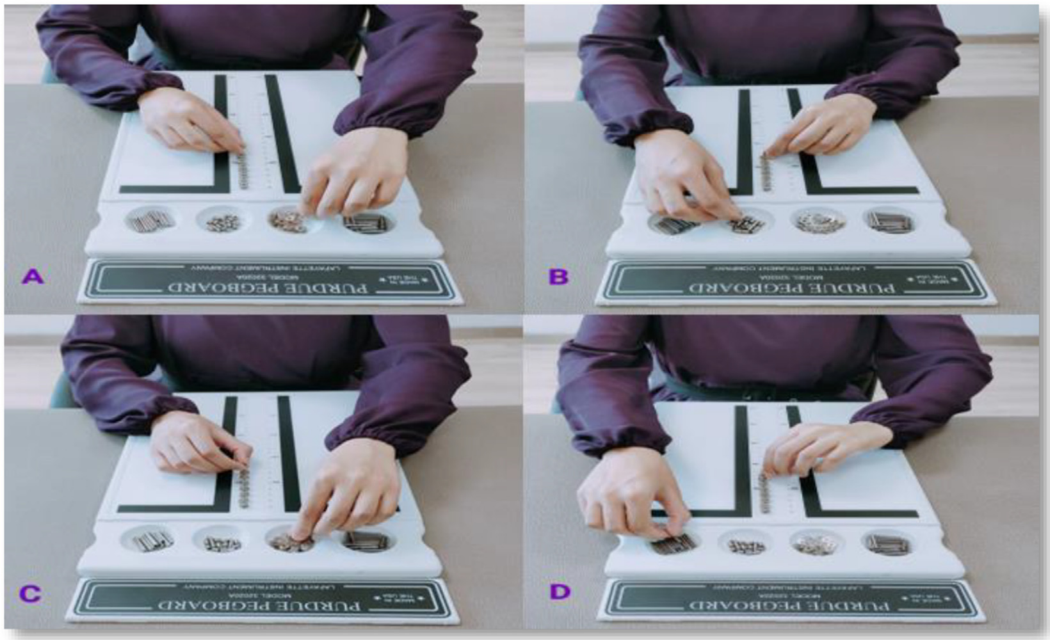

Figure 4: Performance of the assembly Purdue Pegboard Test.

Figure 5: Assessment of dominant handgrip strength.

Figure 6: Assessment of non-dominant handgrip strength.

Table 1: Participants' demographic data.

Variables	$\overline{X}$	± SD
Age (yr)	29.8	2.62
Weight (kg)	61.96	3.09
Height (cm)	162.27	2.67
BMI (kg/m^2)	23.51	0.65

$\overline{X}$: Mean; SD: Standard deviation.

Participants' manual dexterity performance and HGS

Parametric statistical analysis with one-way repeated measures MANOVA revealed statistically significant differences ($P < 0.05$) in the mean values of all outcome measures regarding the PPT tasks (DH, NDH, BH, total, and assembly) and HGS (DH and NDH) among the three tested menstrual cycle phases (Table 2). Pairwise comparison tests indicated statistically significantly higher mean values ($P < 0.05$) for all outcome measures regarding the PPT tasks (DH, NDH, BH, total, and assembly) and HGS (DH and NDH) in the ovulation phase compared to the menstrual and mid-luteal phases. In addition, statistically significantly higher mean values ($P < 0.05$) were observed for all scores of the PPT (DH, NDH, BH, total, and assembly) and HGS (DH and NDH) during the mid-luteal phase compared to the menstrual phase (Table 3).

Table 2: Participants' manual dexterity and HGS during different phases of the menstrual cycle.

Outcome measures	Tested Times			Univariate tests	
	MP	OP	MLP		
	$\overline{X} \pm SD$	$\overline{X} \pm SD$	$\overline{X} \pm SD$	F-value	P-value
PPT scores (No. of components)					
Dominant hand	15.4 ± 1.42	17.08 ± 1.12	16.27 ± 1.08	41.4	0.000*
Non-dominant hand	14.02 ± 1.36	15.53 ± 0.99	14.75 ± 1.15	35.39	0.000*
Both hands	11.52 ± 1.2	12.94 ± 1.09	12.38 ± 0.94	38.37	0.000*
Total	40.93 ± 3.54	45.56 ± 2.73	43.42 ± 2.68	55.36	0.000*
Assembly	33.25 ± 3.6	39.56 ± 4.43	36.34 ± 3.81	68.84	0.000*
HGS scores (kg)					
Dominant hand	21.22 ± 3.64	25.6 ± 4.41	23.4 ± 4.03	62.36	0.000*
Non-dominant hand	19.62 ± 3.33	23.77 ± 3.97	21.92 ± 3.49	65.88	0.000*

$\overline{X}$: Mean; SD: Standard deviation; F-value: One-way repeated measures MANOVA test value; P-value: Probability value; *: Significant at $P \leq 0.05$; MP: Menstrual phase; OP: Ovulation phase; MLP: Mid-luteal phase; PPT: Purdue Pegboard Test; HGS: Handgrip strength.

Table 3: Bonferroni pairwise comparison tests for outcome measures among the three menstrual cycle phases.

Outcome measures	Tested times					
	MP vs. OP		MP vs. MLP		OP vs. MLP	
	MD	P-value	MD	P-value	MD	P-value
PPT scores (No. of components)						
Dominant hand	−1.68	0.000*	−0.87	0.001*	0.81	0.000*
Non-dominant hand	−1.51	0.000*	−0.73	0.003*	0.78	0.000*
Both hands	−1.42	0.000*	−0.86	0.000*	0.56	0.000*
Total	−4.63	0.000*	−2.49	0.000*	2.14	0.000*
Assembly	−6.31	0.000*	−3.09	0.000*	3.22	0.000*
HGS scores (kg)						
Dominant hand	−4.38	0.000*	−2.18	0.000*	2.2	0.000*
Non-dominant hand	−4.15	0.000*	−2.3	0.000*	1.85	0.000*

MD: Mean difference; P-value: Probability value; *: Significant at $P \leq 0.05$; MP: Menstrual phase; OP: Ovulation phase; MLP: Mid-luteal phase; PPT: Purdue Pegboard Test; HGS: Handgrip strength.

Discussion

The main objective of this study was to examine manual dexterity and HGS in healthy female dentists throughout the menstrual cycle. The participants' ages were selected to range from 25 to 35 years old because MSDs frequently affect dental professionals in the early stages of their clinical careers. Older dentists have been found to have lower MSD incidence than younger dentists because their greater work experience frequently allows for efficient work skills in less physically demanding positions. In addition, MSDs are more prevalent among younger female dentists than male dentists, and hormonal factors have been proposed to be factors contributing to women's elevated vulnerability to MSDs.[4,17] The participants' BMI values were selected to be within the normal range (18.5–24.9 kg/m^2) to avoid potential effects of BMI on hand function. Individuals classified as overweight or obese according to BMI often exhibit lower motor skill performance than those with normal BMI values.[18]

In assessing female dentists' manual dexterity with the PPT device, we obtained five separate scores for the DH, NDH, BH, total, and assembly tasks. Regarding the HGS assessment for both DH and NDH, two separate scores were obtained. Contrary to our hypothesis, the results indicated statistically significant differences in all scores of the PPT and HGS throughout the menstrual cycle phases ($P < 0.05$). Statistically significantly higher mean values were observed for all scores of the PPT and HGS during the ovulation phase compared to the menstrual and mid-luteal phases ($P < 0.05$). In addition, statistically significantly higher mean values were obtained for all scores of the PPT and HGS during the mid-luteal phase compared to the menstrual phase ($P < 0.05$). Because this study was considered preliminary research investigating healthy female dentists' manual dexterity and HGS throughout the menstrual cycle, we compared our results with those from prior studies examining manual dexterity and HGS across the menstrual cycle in healthy eumenorrheic women.

Regarding the effects of the menstrual cycle on female dentists' manual dexterity, the obtained results were in line with those reported by Isik et al.,[8] who have observed significantly lower PPT scores for BH, total, and assembly tasks during menstruation than during ovulation in dental students. In addition, in a study by Hampson and Kimura,[12] women assembled more components during the mid-luteal phase than during menstruation. Furthermore, Maki et al.[19] have found that women performed optimal fine motor skills during the mid-luteal phase rather than during menstruation. In contrast, our findings were inconsistent with those of Epting and Overman,[20] who have observed no significant fluctuations in the PPT scores for the DH, BH, and assembly tasks between the menstrual and mid-luteal phases. Additionally, Ikarashi et al.[7] have found no significant fluctuations in women's manual coordination throughout the menstrual cycle.

Fluctuations in women's manual dexterity throughout the menstrual cycle might be associated with the neuromodulatory function of gonadal steroid hormones in the central nervous system. The functional cerebral organization of fine motor coordination is sensitive to ovarian hormones, and estrogen has neuroexcitatory effects, thus positively affecting manual dexterity. In contrast, progesterone inhibits cortical excitability, thereby negatively influencing manual dexterity. In addition, estrogen may enhance manual coordination by affecting dopamine pathways and the cerebellum, which play crucial roles in motor coordination. These explanations have been demonstrated by Jenning et al.[21] and Smith et al.[22]

Regarding the effects of the menstrual cycle on female dentists' HGS, our findings were consistent with those of a study by Sarwar et al.,[23] in which adult women exhibited optimal HGS scores during ovulation rather than during the menstrual and mid-luteal phases. In addition, in a study by Das et al.,[9] adult women had the lowest HGS scores during menstruation. In contrast, our findings were inconsistent with those of Isik et al.,[8] who have reported that dental students' DH and NDH grip strengths did not significantly fluctuate between the menstrual and ovulation phases. Additionally, a study by Nicolay et al.[24] that investigated HGS throughout the menstrual cycle in adult women has revealed non-significant changes among phases.

Fluctuations in HGS throughout the menstrual cycle, with enhanced muscle strength occurring during ovulation, might be associated with the surge in estrogen levels. Because skeletal muscles are estrogen-responsive tissues, the protein levels of estrogen receptors in muscles react to estrogen concentrations, thus causing anabolic effects of estrogen on muscles, whereas progesterone has a catabolic effect. In addition, estrogen concentrations directly affect the binding of myosin heads to actin; therefore, low estrogen concentrations during the menstrual phase might result in fewer myosin fibers attaching to actin during muscle contraction, thus decreasing the muscular force generated. Furthermore, muscles contain testosterone receptors, which are believed to exert anabolic effects enhancing motor system function and muscle contractile properties. Because testosterone levels are high during ovulation, the observed effects might be attributable to this hormone.[23,25]

The discrepancies among previous studies regarding women's hand dexterity and grip strength findings throughout menstrual cycle might be associated with differences in the methods used to assess the menstrual cycle phases, participants' sleep quality and psychological status, and the number of menstrual cycle phases assessed. In addition, rapid reproductive and pituitary hormonal level fluctuations may occur at any time during the same day throughout the menstrual cycle.

The current study provides valuable insights into the influence of the menstrual cycle on manual dexterity and HGS in healthy female dentists. It offers crucial information about the phase of the menstrual cycle that negatively affects hand function in eumenorrheic dentists. Consequently, it may increase female dentists' awareness about the importance of maintaining manual function tasks. Furthermore, it emphasizes that physiotherapists should take the menstrual cycle into account when evaluating female dentists who are experiencing unproficiency in hand function.

Although the current study indicated statistically significant results, several limitations must be considered. First, estrogen and progesterone, which might have helped categorize the menstrual cycle phases more effectively, were not assessed. Second, sleep quality and mood changes, which might influence manual skills, were not considered. Finally, relaxin and testosterone—hormones affecting tissue properties—were not assessed. Future studies are therefore recommended to address these limitations while investigating dentists' hand function throughout the menstrual cycle to identify the possible mechanisms underlying the observed findings.

Conclusions

Female dentists' manual dexterity and HGS fluctuated throughout the regular menstrual cycle, and the best performance was observed during the ovulation phase, followed by the mid-luteal phase. Meanwhile, the lowest manual dexterity and HGS scores were observed during the menstrual phase, thus suggesting that female dentists might be more vulnerable to future musculoskeletal dysfunction during this phase.

Source of funding

This study did not obtain any specific financial support from public, commercial, or not-for-profit entities.

Conflict of interest

There are no potential conflicts of interest regarding this publication.

Ethical approval

This study was approved by the Research Ethical Committee of the Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/004596; date: June 11, 2023). In addition, this study was registered online at ClinicalTrials.gov (NCT06388928; date: April 29, 2024).

Authors' contributions

AIH: Conceptualization, methods, data collection, statistical analysis of data, data interpretation, and writing the article. HMH: Conceptualization, methods, data collection, data interpretation, and supervision. ASS: Data collection and interpretation. All authors have critically reviewed and approved the final draft, and are responsible for the content and similarity index of the manuscript.

Acknowledgments

We thank all study volunteers, who generously provided their time, for their willingness to participate in the study.

References

1. Ayers KMS, Thomson WM, Newton JT, Morgaine KC, Rich AM. Self-reported occupational health of general dental practitioners. **Occup Med (Lond) 2009**; 59(3): 142−148. https://doi.org/10.1093/occmed/kqp004.
2. Saremi M, Rostamzadeh S, Nasr Esfahani M. Hand functionality in dentists: the effect of anthropometric dimensions and specialty. **Int J Occup Saf Ergon 2022**; 28(3): 1473−1481. https://doi.org/10.1080/10803548.2021.1904626.
3. Soo SY, Ang WS, Chong CH, Tew IM, Yahya NA. Occupational ergonomics and related musculoskeletal disorders among dentists: a systematic review. **Work 2023**; 74(2): 469−476. https://doi.org/10.3233/wor-211094.
4. Ohlendorf D, Naser A, Haas Y, Haenel J, Fraeulin L, Holzgreve F, et al. Prevalence of musculoskeletal disorders among dentists and dental students in Germany. **Int J Environ Res Public Health 2020**; 17(23): 8740. https://doi.org/10.3390/ijerph17238740.
5. Rogan MM, Black KE. Dietary energy intake across the menstrual cycle: a narrative review. **Nutr Rev 2023**; 81(7): 869−886. https://doi.org/10.1093/nutrit/nuac094.
6. Casey E, Hameed F, Dhaher YY. The muscle stretch reflex throughout the menstrual cycle. **Med Sci Sports Exerc 2014**; 46(3): 600−609. https://doi.org/10.1249/mss.0000000000000134.
7. Ikarashi K, Sato D, Iguchi K, Baba Y, Yamashiro K. Menstrual cycle modulates motor learning and memory consolidation in humans. **Brain Sci 2020**; 10(10): 696. https://doi.org/10.3390/brainsci10100696.
8. Işik Eİ, Soygun K, Kahraman ÖC, Koçak EF. The effect of the menstrual cycle on the sense of touch, grip strength and manual dexterity of dental students. **Int J Occup Saf Ergon 2022**; 28(2): 1167−1175. https://doi.org/10.1080/10803548.2021.1880714.
9. Das A, Bania D, Dutta N, Borgohain MK. Study of hand grip strength, handgrip endurance and fatigue in different phases of menstrual cycle of adults. **J Popl Ther Clin Pharmacol. 2023**; 30(16): 189−194. https://doi.org/10.47750/jptcp.2023.30.16.024.
10. Ko S, Lee J, An D, Woo H. Menstrual tracking mobile app review by consumers and health care providers: quality evaluations study. **JMIR mHealth uHealth 2023**; 11:e40921. https://doi.org/10.2196/40921.
11. Abt JP, Sell TC, Laudner KG, McCrory JL, Loucks TL, Berga SL, et al. Neuromuscular and biomechanical characteristics do not vary across the menstrual cycle. **Knee Surg Sports Traumatol Arthrosc 2007**; 15(7): 901−907. https://doi.org/10.1007/s00167-007-0302-3.
12. Hampson E, Kimura D. Reciprocal effects of hormonal fluctuations on human motor and perceptual-spatial skills. **Behav Neurosci 1988**; 102(3): 456−459. https://doi.org/10.1037//0735-7044.102.3.456.
13. Levanon Y, Lugassy D, Pilo R, Nassar R, Mhana A, Maria Z, et al. Assessment of the modified O'Connor Tweezer Dexterity and Purdue Pegboard test for use among dental students. **J Dent Educ 2023**; 87(4): 533−539. https://doi.org/10.1002/jdd.13137.
14. Tarnopolsky MA. Effect of caffeine on the neuromuscular system–potential as an ergogenic aid. **Appl Physiol Nutr Metab 2008**; 33(6): 1284−1289. https://doi.org/10.1139/h08-121.
15. Tiffin J, Asher EJ. The Purdue pegboard; norms and studies of reliability and validity. **J Appl Psychol 1948**; 32(3): 234−247. https://doi.org/10.1037/h0061266.
16. Huang L, Liu Y, Lin T, Hou L, Song Q, Ge N, et al. Reliability and validity of two hand dynamometers when used by community-dwelling adults aged over 50 years. **BMC Geriatr 2022**; 22(1): 580. https://doi.org/10.1186/s12877-022-03270-6.
17. Al-Hourani Z, Nazzal M, Khader Y, Almhdawi K, Bibars AR. Work-related musculoskeletal disorders among Jordanian dental technicians: prevalence and associated factors. **Work 2017**; 56(4): 617−623. https://doi.org/10.3233/wor-172524.
18. Badicu G, Zamani Sani SH, Fathirezaie Z, Esmaeili M, Bassan JC, González-Fernández FT, et al. Does body mass index distinguish motor proficiency, social and emotional maturity among adolescent girls? **BMC Pediatr 2023**; 23(1): 618. https://doi.org/10.1186/s12887-023-04443-x.
19. Maki PM, Rich JB, Rosenbaum RS. Implicit memory varies across the menstrual cycle: estrogen effects in young women. **Neuropsychologia 2002**; 40(5): 518−529. https://doi.org/10.1016/s0028-3932(01)00126-9.
20. Epting LK, Overman WH. Sex-sensitive tasks in men and women: a search for performance fluctuations across the menstrual cycle. **Behav Neurosci 1998**; 112(6): 1304−1317. https://doi.org/10.1037//0735-7044.112.6.1304.
21. Jennings PJ, Janowsky JS, Orwoll E. Estrogen and sequential movement. **Behav Neurosci 1998**; 112(1): 154−159. https://doi.org/10.1037//0735-7044.112.1.154.
22. Smith MJ, Adams LF, Schmidt PJ, Rubinow DR, Wassermann EM. Effects of ovarian hormones on human cortical excitability. **Ann Neurol 2002**; 51(5): 599−603. https://doi.org/10.1002/ana.10180.
23. Sarwar R, Niclos BB, Rutherford OM. Changes in muscle strength, relaxation rate and fatiguability during the human menstrual cycle. **J Physiol. 1996**; 493(Pt 1): 267−272. https://doi.org/10.1113/jphysiol.1996.sp021381.
24. Nicolay CW, Kenney JL, Lucki NC. Grip strength and endurance throughout the menstrual cycle in eumenorrheic and women using oral contraceptives. **Int J Ind Ergon 2008**; 38(2): 211−221. https://doi.org/10.1016/j.ergon.2008.01.002.
25. Niering M, Wolf-Belala N, Seifert J, Tovar O, Coldewey J, Kuranda J, et al. The influence of menstrual cycle phases on maximal strength performance in healthy female adults: a systematic review with meta-analysis. **Sport (Basel, Switzerland) 2024**; 12(1): 31. https://doi.org/10.3390/sports12010031.

How to cite this article: Hassanein AI, Hanfy HM, Kamel HA-DH, Shaban AS. Manual dexterity characteristics throughout the menstrual cycle in healthy female dentists: An observational study. J Taibah Univ Med Sc 2024;19(6):1077−1084.