DOI: https://doi.org/10.17921/2447-8938.2024v26n3p169-176

Effect of Therapeutic Horseback Riding on Masticatory Performance and Quality of Life in Older Adults

Efeito da Equitação Terapêutica no Desempenho Mastigatório e na Qualidade de Vida de Adultos Mais Velhos

Edneia Corrêa de Mello[a]; Lígia Maria Napolitano Gonçalves[a]; Marcelo Palinkas[a]; Paulo Batista de Vasconcelos[a]; Christiane Maus Martins[b]; Elaine Cristina Soares Leite[b]; Octávio Barbosa Neto[c]; Edmar Lacerda Mendes[d]; Simone Cecílio Hallak Regalo[a]; Selma Siessere[a]

[a]Universidade de São Paulo, Faculdade de Odontologia de Ribeirão Preto, Programa de Pós-Graduação em Biologia Oral. SP, Brazil.
[b]Associação de Equoterapia Vassoural. SP, Brazil.
[c]Universidade Federal do Triangulo Mineiro, Departamento de Ciências do Esporte. MG, Brazil.
[d]Universidade Federal do Ceará, Departamento de Fisiologia e Faramacologia. CE, Brazil.
E-mail: edneia.mello@alumni.usp.br

Abstract

Regular physical activity combined with adequate nutrition delays the loss of functional capacity and promotes healthy aging. Therapeutic horseback riding (THR) involves interactions with horses and provides physical, cognitive, and social benefits. However, the effect of THR on masticatory performance remains unclear. Therefore, this study aimed to evaluate the effects of a THR Program on masticatory performance and quality of life in older adults. Sixteen participants (60-79 years old) underwent three months of THR, with two visits to the center per week, on non-consecutive days. Masticatory performance was assessed using surface electromyography (EMG) for masseter and temporalis muscles (Trigno™ Wireless EMG System), strength of occlusal contacts by the T-Scan® III (Occlusal Analysis System) and the quality of life by the World Health Organization Quality of Life Group for Older Persons (WHOQOL-OLD). EMG values decreased in most conditions evaluated, with a statistical effect of time (pre vs. post-THR Program) (p=0.023) and clinical condition (habitual chewing of soft food vs. resistant food vs. non-habitual chewing with parafilm) (p=0.025) for the left temporalis muscle, as well as a difference between habitual chewing of soft food and non-usual chewing (p=0.023). A trend towards a clinical increase in the strength of the occlusal contacts in the right and left hemiarches was observed. There was no significant difference for the WHOQOL-OLD scores. In conclusion, THR improves masticatory performance in older adults. These findings are relevant, as chewing is the first phase of digestion, important for nutrition and necessary for a healthy life.

Keywords: Aging. Electromyography. Equine-Assisted Therapy. Hippotherapy. Masticatory Muscles.

Resumo

A atividade física regular aliada à alimentação adequada retarda a perda da capacidade funcional e promove um envelhecimento saudável. A equitação terapêutica (ET) envolve interações com cavalos que proporcionam benefícios físicos, cognitivos e sociais. Entretanto, o efeito da ET no desempenho mastigatório permanece obscuro. Portanto, este estudo objetivou avaliar os efeitos de um Programa de ET no desempenho mastigatório e na qualidade de vida de adultos mais velhos. Dezesseis participantes (60-79 anos) foram submetidos a três meses de ET, com dois atendimentos semanais, em dias não consecutivos. O desempenho mastigatório foi avaliado por meio da eletromiografia (EMG) de superfície para os músculos masseter e temporal (TrignoTM Wireless EMG System), a força de contatos oclusais pelo T-Scan® III (Oclusal Analysis System) e a qualidade de pelo World Health Organization Quality of Life Group for Older Persons (WHOQOL-OLD). Os valores da EMG reduziram na maioria das condições avaliadas, com efeito estatistico do tempo (pré vs. pós-Programa) (p=0,023) e da condição clínica (mastigação habitual de alimentos macios vs. resistentes vs. mastigação não habitual com parafilme) (p=0,025) para o músculo temporal esquerdo, bem como diferença entre mastigação habitual de alimentos macios e não habitual (p=0,023). Observou-se tendência de aumento clínico da força dos contatos oclusais nas hemiarcas direita e esquerda. Não houve diferença estatística para os escores do WHOQOL-OLD. Concluindo, a ET melhora o desempenho mastigatório em adultos mais velhos. Esses achados são relevantes, pois a mastigação é a primeira fase da digestão, importante para a nutrição e necessária para uma vida saudável.

Palavras-chave: Envelhecimento. Eletromiografia. Terapia Assistida por Equinos. Equoterapia. Músculos Mastigatórios.

1 Introduction

Population aging has stimulated the development of approaches aimed at maintaining the global functionality of individuals. An established field of scientific research on biological aging is geroscience, focused on 'optimal longevity' - living long but with good health and quality of life[1].

Aging naturally results in reduced muscle strength, which affects the general health of the body, including that of the stomatognathic system[2]. A decrease in the volume, consistency, and contractility of muscle fibers affects the performance of the masticatory muscles, especially the masseter muscles[3]. Difficulties chewing result in reduced fiber consumption, increased nutritional problems, and gastrointestinal diseases[4]. Furthermore, inadequate performance of the masticatory muscles compromises other stomatognathic functions (breathing, swallowing, sucking, and speech articulation)[5].

Several studies have correlated oral function with fall risk in older adults[6,7].

However, promising findings indicate that regular physical activity, combined with adequate nutritional intake, delays the loss of functional capacity and fosters healthier aging[8]. As physical activity and nutrition are the two pillars of a healthy life, different studies have linked physical training to masticatory performance[9,10]. For example, the intensity of physical exercise can modify the pattern of the masticatory muscles. High-intensity training alters the intracellular concentrations of several metabolites, reduces energy-dependent processes, and leads to the accumulation of degradation products with harmful effects. Therefore, masticatory efficiency reduces immediately after intense exercise[11]. Information on the effect of a specific type of physical training on the masticatory system helps guide athletes, coaches, and nutritionists regarding possible decreases in masticatory capacity and the most appropriate form of post-workout nutrition[11,12]. Conversely, moderate physical activity can improve masticatory performance in older adults[13]. Moreover, other findings have shown that the level of physical fitness and independence in performing activities of daily living has a positive impact on the oral health of this age group[14,15].

The field of human-animal interactions, and more specifically, equine-assisted interventions, has evolved significantly over the last half century[16]. Equine-Assisted Services (EAS) have proven to be an efficient resource for improving the quality of life of different clinical populations, including older adults[17]. Activities involving horses, such as riding or just interacting with them, has been shown to substantially improve social interaction, behavioral, and physical functions. The human-equine bond favors sensory, emotional, cognitive, behavioral, and relational experiences[18]. Through therapeutic horseback riding (THR), an EAS resource, participants improve their muscular strength, motor coordination, balance, emotional control, and self-esteem[19,20]. Moreover, it is an effective therapy for improving brain activity in older adults and controlling hormonal levels, such as reducing cortisol and increasing serotonin[21,22]. Interventions involving horses have received increasing attention from the scientific community.

However, studies that analyze the impact of THR on the stomatognathic system are scarce. Therefore, our study aimed to evaluate the effects of a THR Program on masticatory performance and quality of life in older adults. We hypothesized that THR improves masticatory efficiency, occlusal contact at the maxilla/mandible interface and quality of life in older adults.

2 Material and Methods

2.1 Study design and participants

This was a longitudinal, prospective, and self-controlled study, approved by the Ethics Committee of the University of São Paulo Faculty of Dentistry of Ribeirão Preto in accordance with resolution CNS 466/12 of the National Health Council (CAEE:98201118.2.0000.5419), the approval opinion number is 2.952.323. The study was conducted using the Brazilian Clinical Trials Registry (Rebec). Participants were informed verbally and in writing about the objectives and stages of the research, and voluntarily signed an informed consent form.

A priori sample size calculation was performed using G* Power 3.1.9.2 software (Franz Faul, Kiel University, Kiel, Germany) considering the level of $\alpha = 0.05$, power of 95% for the primary outcome of electromyographic (EMG) amplitude during Parafilm chewing for the left temporalis muscle in older adults after hippotherapy (mean [SD] pre -intervention 9.75 [2.58] and post-intervention 5.79 [0.93])[13]. The effect size was 0.97. A minimum sample size of six was obtained.

Initially, 40 individuals were recruited from the cities of Sertãozinho and Pontal, SP, Brazil, without distinction based on sex, race, or social class. The inclusion criteria were as follows: healthy individuals of both sexes, aged 60 years or older, who were starting to practice THR during the study period, who did not have an uncontrollable fear of horses, shoulder or hip dislocation, severe spine problems, acute heart disease, epilepsy, and/or uncontrolled high blood pressure. The inclusion criteria were determined by clinical examination and anamnesis, and information regarding personal data and medical history was obtained. The study began with 30 participants, and concluded with 16 participants, with an average age of 68.5 (±4.5) years (12 women: 70.4 [±6.1] years; 4 men: 66.5 [±4.3] years). The reason for the large loss of participants was the location of the interventions being in rural areas. Free public transport was only available to early participants. For the others, this option was not available due to lack of resources. Then, the participants were encouraged to carpool. Even so, this resource became unfeasible, as the majority of participants did not have a driver's license.

2.2 Assessment procedures

Assessments of the masticatory system were performed using a standard procedure followed/developed at the Electromyography Laboratory of Dr. Mathias Vitti from the Department of Basic and Oral Biology at the University of São Paulo Faculty of Dentistry, Ribeirão Preto. Assessments were performed before and three months after the THR Program.

Masticatory efficiency was assessed by a specialist from the aforementioned laboratory. Initially, the skin was cleaned with alcohol to reduce the signal impedance. After a few minutes, the surface EMG electrodes were positioned bilaterally on the masseter and temporalis muscles[23]. To ensure the correct location of the masseter and temporalis muscles, specific maximal voluntary isometric contraction maneuvers were performed, accompanied by palpation[24]. The EMG signals of the chewing cycles were collected using a Trigno Wireless EMG System (Delsys Inc., Boston, MA, USA). EMG recordings were performed for ten seconds in the following clinical conditions: habitual chewing of resistant food (4 g of Confeitos M&M Amendoim – Mars® S/A), habitual chewing of soft food (half chocolate Bis-Lacta® S/A) and chewing unusual food (Parafilm M®, Pechinery Plastic Packaging, Batavia, IL, USA). Parafilm is an inert material made up of a folded sheet of paraffin (18×17×4 mm, weighing 245 mg) that is inserted between the occlusal surfaces of the first and second permanent molars on both sides of the dental arches[23].

During nonhabitual chewing, the participants were asked to make a short opening movement to reduce the effects of changes in length versus (vs) tension on the muscle, which is typical in dynamic EMG recordings[25]. To avoid possible sources of bias, three initial chewing cycles were excluded, because the first jaw movement varied considerably at the beginning of the chewing process. Consequently, the linear envelopment integral of the following masticatory cycles was used to calculate the results[11]. The environment was kept calm and silent. Each participant was seated with the trunk and head erect, feet flat on the floor, and hands resting on the thighs. The necessary instructions and explanations were provided, asking the participants to remain calm[23].

Digital occlusal analysis at the maxilla/mandible interface was performed by a dental surgeon, qualified to use the T-Scan® III Occlusal Analysis System (Tekscan Inc., Ann Arbor, MI, USA). Initially, we tested whether the bite-guide support was compatible with the size of the participant's oral cavity. The support and sensors were then fitted to the device handstrap. We then waited for the green light to activate signaling that the sensor was correctly connected and ready for use. Next, the support with the sensor was inserted into the oral cavity, with the position guide centered and fitted between the upper central incisors.

The participants were seated with the trunk and head erect, keeping their feet flat on the floor, and their hands resting on the thighs. To avoid the risk of bias, the evaluator instructed the participants to bite the sensor three times until 95–100% of the maximum force of the occlusal contacts was achieved[26]. The sensor was 0.102 mm thick and did not interfere with the natural bite[27]. The data were analyzed and stored using T-Scan Software. The dynamics of the force of occlusal contacts were recorded to analyze the interrelationship of the occlusal surfaces of the right and left hemiarchs (upper and lower) and the upper and lower first molars in terms of the percentage force of a maximal voluntary contraction[28].

Quality of life was assessed by the physiotherapist responsible for the Vassoural Equine Therapy Association using the World Health Organization Quality of Life Group for Older Persons (WHOQOL-OLD), pre and post-THR Program. The questionnaire consists of 24 items assigned to six domains: (1) sensory functioning; (2) autonomy; (3) past, present, and future activities; (4) social participation; (5) death and dying; and (6) intimacy. The questionnaire provided answers recorded on a Likert scale, with values from one to five. The scores from these six domains were summed to obtain the total score for each participant. The higher the score, the better the quality of life; the total score was 120 points[29].

2.3 Intervention

The THR Program was conducted for three months, with two visits per week, on non-consecutive days. The THR sessions were held at the Vassoural Equine Therapy Association, Pontal, SP, Brazil. The Association has a multidisciplinary team comprising physiotherapists, psychologists, occupational therapists, nurses, physical educators, and equestrians trained by the National Equine Therapy Association (ANDE-BRASIL). Four horses were included in the THR Program. In each session, participants rode a randomly chosen horse. During the intervention, horses were led by a handler at a speed of approximately 4 km/h. The riding equipment used included a halter and an English saddle with stirrups.

2.4 Statistical analysis

Repeated measures analysis of variance (ANOVA-MR) was used to calculate the effects of time (pre vs. post THR Program), clinical condition (habitual chewing of soft food vs. resistant food vs. non-habitual chewing with parafilm), and interaction (time vs. clinical condition). Sphericity was tested using Mauchly's test, and homogeneity of variance was tested using Levene's test. If sphericity was violated, the Greenhouse-Geisser correction was used. Bonferroni multiple comparison tests were performed when the null hypothesis was rejected after ANOVA-MR analysis for clinical conditions. Cohen's coefficient was used to estimate the effect size ($\eta 2$) of the intervention, interpreted as small ($\eta 2=0.2$), medium ($\eta 2=0.5$) or large ($\eta 2=0.8$)[30]. After verifying the normal distribution of the sample (Shapiro-Wilk test), a paired t-test was used to evaluate the WHOQOL-OLD). A significance level of 5% was used for all procedures. All analyses were performed using SPSS (version 20.0; SPSS Inc., Chicago, IL, USA).

3 Results and Discussion

The analysis of masticatory efficiency showed a clinical reduction in mean EMG values after the THR Program for all muscles evaluated in nonhabitual and habitual chewing of soft food and for the right (RT) and left (LT) temporalis muscles in habitual chewing of resistant food. Statistical effect of time [$F(1,42)=5.569$, $p=0.023$; $\eta 2=0.117$] and clinical condition [$F(1,42)=4.041$, $p=0.025$; $\eta 2=0.161$] were found for the LT muscle. Bonferroni's multiple comparison tests revealed a statistically significant difference in LT muscle activity between habitual chewing of soft food and nonhabitual chewing ($p=0.022$) (Table 1).

Table 1 - Mean, Standard Deviation (±), statistical significance ($p<0.05$) of the Effect of Time, Clinical Condition (CC) and Interaction of Time versus Clinical Condition of electromyographic data for the right and left masseter (RM, LM) and right and left temporal muscles (RT, LT), in the Habitual Chewing of Resistant Food, Soft Food and Unusual Chewing Pre and Post-Therapeutic Horse Riding Program

		Chewing			Effect of		
Muscle	**Time**	**Resistant Food**	**Soft Food**	**Unusual Chewing**	**Time (*p*)**	**CC (*p*)**	**Interaction (*p*)**
RM	Pre	33.94±18.05	27.37±17.94	37.14±18.88	0.263	0.215	0.201
	Post	37.02±19.37	22.95±14.82	31.06±22.21			
LM	Pre	30.51±14.15	29.71±16.17	35.34±19.31	0.087	0.240	0.339
	Post	31.39±14.90	21.43±06.78	27.70±09.67			
RT	Pre	20.64±08.30	18.45±09.16	25.87±2.15	0.054	0.135	0.641
	Post	19.67±06.29	15.69±07.42	21.92±10.76			
LT	Pre	25.37±08.31	23.21±10.93	31.70±14.25	**0.023**	**0.025**	0.832
	Post	22.53±06.77	**18.17±06.89***	**27.44±09.06***			

*denotes statistical difference.
Source: research data.

The evaluation of the strength of occlusal contacts at the maxilla-mandible interface revealed a trend of clinical increase for the right and left hemiarches and changes in mean values for the upper permanent molars (teeth 16 and 26) and lower permanent molars (teeth 36 and 46) after the THR Program, without statistical significance (Table 2).

Table 2 - Mean, Standard Deviation (±), statistical significance ($p<0.05$) of the Effect of Time for the Contact of Occlusal Forces (%) in the Right and Left Hemiarch Region of Teeth 16, 26, 36, 46, for the Right Hemiarch versus (vs) Left Hemiarch, of Teeth 16 vs 26 and 36 vs 46 Pre and Post-Therapeutic Horse Riding Program

Occlusal Forces	**Time**		**Effect of Time (*p*)**
Region	**Pre**	**Post**	
Right Hemiarch	47.47±12.68	47.45±14.49	0.289
Left Hemiarch	50.43±11.17	52.55±14.49	0.399
Teeth 16	14.55±9.69	16.59±8.63	0.906
Teeth 26	10.35±4.66	9.30±4.21	0.105
Teeth 36	11.28±2.77	11.09±5.19	0.161
Teeth 46	14.02±10.68	13.26±4.87	0.853
Right vs Left Side	**Time**		**(*p*)**
Right Hemiarch vs Left Hemiarch	47.47±12.68 **(Pre)** 47.45±14.49 **(Post)**	50.43±11.17 52.55±14.49	0.744 0.415
Teeth 16 vs 26	14.55±9.69 **(Pre)** 16.59±8.63 **(Post)**	10.35±4.66 9.30±4.21	0.572 0.073
Teeth 36 vs 46	11.28±2.77 **(Pre)** 11.09±5.19 **(Post)**	14.02±10.68 13.26±4.87	0.405 0.171

Source: research data.

The WHOQOL-OLD assessment indicated a clinical increase in mean values in 11 of the 24 questions and in two of the six domains, but the difference was not statistically significant (Table 3).

Table 3 - Mean, standard deviation (±), statistical significance ($p \leq 0.05$) for each question, domain and the total sum of the World Health Organization Quality of Life Group for Older Persons (WHOQOL-OLD) Pre and Post-Therapeutic Horse Riding Program

WHOQOL-OLD		**Pre**	**Post**	**(*p*)**
Questions	1 - loss of senses affects daily life	2.55±0.92	2.16±1.04	0.261
	2 - loss of senses affects ability to participate in activities	2.55**±1.29**	1.94**±1.21**	0.110
	3 - freedom to make your own decisions	3.33±0.97	3.61±1.09	0.311
	4 - control of the future	3.38±1.03	3.27±1.22	0.607
	5 – freedom respected	3.94±0.80	3.50±0.92	0.057
	6 – concern about the type of death	2.33±1.41	2.44±1.29	0.777
	7 - fear of not controlling death	2.44±1.04	3.00±1.37	0.213
	8 - fear of dying	2.66±1.28	2.16±0.95	0.132
	9 - fear of suffering pain before dying	3.11±1.27	3.55±0.98	0.190
	10 - functioning of the senses affects the ability to interact	2.33±1.23	2.00±1.02	0.438
	11 – do what you would like to do	3.55±0.61	3.55±0.70	1.000
	12 – satisfied with achievements in life	3.72±0.66	3.61±0.91	0.542

Continue...

	13 - recognition you deserve in life	3.05±1.21	3.44±0.92	0.149
	14 - have enough to do each day	3.50±1.04	3.66±0.68	0.454
	15 - satisfied with what you have achieved in life	4.05±0.93	4.22±0.54	0.579
	16 - satisfied with the way you use your time	3.77±1.16	3.72±0.89	0.875
	17 - satisfied with the level of activity	4.05±0.87	4.05±0.63	1.000
	18 - satisfied with participation in the community activities	4.11±1.02	4.16±0.61	0.816
	19 - happy with what can be expected in the future	3.88±0.96	4.05±0.63	0.454
	20 - assessment of the functioning of the senses	3.88±0.58	3.66±0.68	0.298
	21 - feeling of companionship in life	3.38±0.84	3.44±1.04	0.834
	22 - feel love in life	4.00±0.48	4.11±0.47	0.542
	23 - opportunity to love	3.55±1.04	3.50±0.92	0.826
	24 - opportunity to be loved	3.55±1.04	3.50±0.78	0.790
Domais	(1) Sensory Functioning	11.83±2.52	11.00±3.21	0.269
	(2) Autonomy	16.83±4.00	16.66±3.04	0.864
	(3) Past, Present and Future Activities	21.66±3.61	22.22±3.04	0.525
	(4) Social Participation	15.94±2.53	15.94±1.55	1.000
	(5) Death and Dying	7.38±1.09	7.55±1.33	0.674
	(6) Intimacy	7.11±2.02	7.00±1.64	0.794
	Total	**80.77±10.51**	**80.38±8.81**	**0.830**

Source: research data.

The population is increasingly interested in improving their quality of life and health in general. A growing body of literature suggests that oral health and chewing influence cognitive and systemic health during aging[31]. Thus, a good level of physical fitness and oral function are necessary for healthy lifestyle habits, including physical exercise and diet[6,8]. The decline in muscle strength in the stomatognathic system as a function of age becomes more evident in the masseteric muscles, especially when some or even all teeth are lost[2,3]. Consequently, physical activity, which aims to delay the consequences of aging, is essential for old age[32]. The findings of the present study showed that the THR Program improved masticatory performance but not the quality of life in older adults; therefore, the null hypothesis was partially rejected.

Chewing involves a complex sensorimotor interaction between the central and peripheral nervous systems[33]. Chewing involves coordinated action of the tongue, jaw, and masticatory muscles[11]. EMG is considered the gold standard for analyzing muscle activity. Changes in the coordination pattern of the masticatory muscles, mainly the masseter and temporalis muscles, allow for the diagnosis of the stomatognathic system[24]. The tool used to analyze the masticatory efficiency in this study was the integral of the EMG signal linear envelopment , which is capable of analyzing only the periods of isometric contractions of chewing cycles and signals possible changes[23]. Chewing dynamics are composed of movements of isotonic contractions interspersed with periods of isometric contractions. After food is placed in the mouth, the jaw-lowering and jaw-elevating muscles contribute significantly to chewing. During habitual and non-habitual chewing, the myoelectric activity of the masseter muscle is greater than that of the temporalis muscle because of its greater action potential[34]. Our results confirmed this pattern of superior myoelectric activity in the masseters compared to those in the temporalis muscles in all EMG evaluations, both before and after the THR Program.

The mean EMG activity in the TL muscle reduced after the THR Program. This result is desirable as fewer muscle fibers are recruited to perform the same chewing function in healthy individuals than in individuals with morphofunctional changes such as osteoarthrosis[23]. Changes in the stomatognathic system consequently generate greater EMG activity in the masticatory muscles and favor muscle fatigue[35].

The effect of clinical condition showed that nonhabitual chewing resulted in higher mean EMG values for the LT muscle than habitual chewing of soft food. This result was expected because during unusual chewing, a short excursion movement of opening and closing the mouth occurs[11]. Accordingly, the effort of the masticatory muscles to perform unusual chewing with parafilm is greater than that associated with chewing soft food. A similar result was reported in another study using hippotherapy[13]. However, the greater the consistency of the food, the higher the EMG activity. In other words, the more resistant the food, the greater is the activity required by the muscle[36]. In the present study, masticatory performance was carried out two days after the end of the THR Program. Thus, participants had the opportunity to replace their metabolites through food. The THR Program was moderately intense.

The digital occlusal analysis system makes it possible to evaluate a patient's occlusion in real time by analyzing the position and distribution of occlusal contacts as well as the intensity of their force. The trend of clinical increase in the right and left hemiarches after the THR Program is desirable, as it indicates better masticatory performance[26]. The absence of a statistical difference does not necessarily imply clinical irrelevance, as when the occlusion is normal or almost normal, the patient's initial tooth contact tends to remain the same throughout the treatment. Conversely, when occlusion is altered, as in bilateral condylar fractures, where the mandible is displaced from its natural position, neuromuscular adaptations are very noticeable during recovery[37]. The minimal differences found between the mean values of the right and left hemiarches as well as in the molar region indicate that the participants had a balanced occlusion, and this occlusal balance was maintained after the THR Program[38]. Considering our findings, we can infer that the tonic adjustments that occurred in the participant's entire body due to equine movements did not interfere with the occlusal balance. To our knowledge, this study is the first to analyze this parameter; therefore, no other results are available for a comparison.

The success of the THR Program may be attributed to several factors. Horses can be used as reproducible rehabilitation[39]. Equine movement, a valuable kinesiotherapy tool, promotes anticipatory and compensatory postural adjustments in participants[18]. This repetitive and rhythmic movement favors effective motor learning, resulting in improved balance, motor coordination, and gait[19,40,41]. For example, information from the visual, vestibular, auditory, and somatosensory systems has unique characteristics that help the central nervous system make postural adjustments[42]. Consequently, the neurofunctional reorganization that occurs naturally with the three-dimensional stimuli emitted by horses improves functional capacity and masticatory performance[13,19]. Furthermore, the pelvic mobilization that occurs during THR favors diaphragmatic breathing because it promotes accommodation of the organs located in the abdomen, lowers the diaphragm, and consequently increases the inspiratory volume[44]. Diaphragmatic breathing is considered ideal because it can stimulate relaxation and relieves the symptoms of anxiety, tension, and stress[44]. Stress and anxiety predispose individuals to bruxism, which impairs masticatory efficiency[35]. The human-equine bond is also effective in reducing stress, controlling hormone levels (reducing cortisol and increasing serotonin), and improving brain activity in older adults[21,22]. The physical, cognitive, and social benefits of THR positively affected the participants' quality of life[17,45].

Quality of life is complex and encompasses social relationships, lifestyle, psychological states, and physical health[46]. The WHOQOL-OLD results were unexpected, because other studies have shown that THR improves the quality of life of older adults[17,47]. A possible explanation is that the universe of knowledge on quality of life is expressed as a multidisciplinary area of understanding that encompasses various forms of science and popular knowledge and concepts that permeate people's lives as a whole[29]. For example, Question 5 ("freedom respected") showed the largest negative change. This question belongs to the "Autonomy" domain, referring to independence, describing the extent to which older adults are capable of living autonomously and make their own decisions. In our sample, some individuals were institutionalized; that is, some aspects involved social issues. Alternatively, some patterns of thinking and behavior may take longer to change. For example, studies that identified a positive impact of THR on quality of life covered a period of six months or more of intervention[21,48]. Hence, the duration of THR programs should be extended.

A limitation of this study was the impossibility of including a control group; that is, we used a within-subjects design to compare the group results before and after the THR Program. However, the main strength of the present study was the evaluation of masticatory performance and quality of life using instruments highly validated in scientific research, such as electromyography, digital occlusal analysis, and the WHOQOL-OLD.

Future research should explore the impact of a longer THR Program and whether these results extend to other clinical populations, such as those with physical or cognitive disabilities and different age groups.

4 Conclusion

The THR Program improved masticatory performance in older adults. THR is an important resource for improving physical performance that consequently affects oral function. These findings are relevant, as chewing is the first phase of digestion, important for nutrition and necessary for a healthy life. The benefits of the human-equine bond are relevant for all professionals who evaluate humans comprehensively, understanding that physical, psychological, cognitive, and social aspects are interconnected.

Acknowledgments

Associação de Equoterapia Vassoural (AEV) for infrastructure, City Hall of Sertãozinho and Pontal - SP. Foundation for Research Support of the State of São Paulo (FAPESP), National Council for Scientific and Technological Development (CNPq) and Coordination for the Improvement of Higher Education Personnel (CAPES). This study financed in part by the CAPES - Finance Code 001; and FAPEMIG.

References

1. Seals DR, Justice JN, LaRocca TJ. Physiological geroscience: targeting function to increase healthspan and achieve optimal longevity. J Physiol (Lond) 2016;594(8):2001-24. doi: 10.1113/jphysiol.2014.282665

2. Galo R, Vitti M, Santos CM, Hallak JEC, Regalo SCH. The effect of age on the function of the masticatory system: an electromyographical analysis. Gerodontology 2006;23(3):177-82. doi: 10.1111/j.1741-2358.2006.00113.x

3. Palinkas M, Nassar MSP, Cecílio FA. Age and gender influence on maximal bite force and masticatory muscles thickness. Arch Oral Biol 2010;55(10):797-802. doi: 10.1016/j.archoralbio.2010.06.016

4. Tosello A, Foti B, Sédarat C. Oral functional characteristics

and gastrointestinal pathology: an epidemiological approach. J Oral Rehabil 2001;28(7):668-72. doi: 10.1046/j.1365-2842.2001.00730.x

5. Abreu MHD, da Silva APL, Cavalcanti RVA. Prevalence of chewing difficulty in older people in long-term care: a systematic review and meta-analysis. Gerodontology 2022. doi: 10.1111/ger.12617

6. Murotani Y, Hatta K, Takahashi T. Oral Functions Are Associated with Muscle Strength and Physical Performance in Old-Old Japanese. Int J Environ Res Public Health 2021;18(24):13199. doi: 10.3390/ijerph182413199

7. Yamamoto T, Kondo K, Misawa J. Dental status and incident falls among older Japanese: a prospective cohort study. BMJ Open 2012;2(4):e001262. doi: 10.1136/bmjopen-2012-001262

8. Güneşliol BE, Karaca E, Ağagündüz D, Acar ZA. Association of physical activity and nutrition with telomere length, a marker of cellular aging: a comprehensive review. Crit Rev Food Sci Nutr 2023;63(5):674-92. doi: 10.1080/10408398.2021.1952402

9. Huang DH, Chou SW, Chen YL, Chiou WK. Frowning and jaw clenching muscle activity reflects the perception of effort during incremental workload cycling. J Sports Sci Med 2014;13(4):921-8.

10. Mendoza-Puente M, Oliva-Pascual-Vaca Á, Rodriguez-Blanco C, Heredia-Rizo AM, Torres-Lagares D, Ordoñez FJ. Risk of headache, temporomandibular dysfunction, and local sensitization in male professional boxers: a case-control study. Arch Phys Med Rehabil 2014;95(10):1977-83. doi: 10.1016/j.apmr.2014.06.011

11. Júnior MCBL, Goiato MC, de Caxias FP. Masticatory efficiency, bite force and electrical activity of the masseter and temporalis muscles in bodybuilders. J Clin Exp Dent 2021;13(9):920-6. doi: 10.4317/jced.58368

12. Ginszt M, Zieliński G, Byś A, Gawda P, Majcher P. Masticatory Muscles Activity in Sport Climbers. Int J Environ Res Public Health 2020;17(4):1378. doi: 10.3390/ijerph17041378

13. Mello EC, Regalo SCH, Diniz LH. Electromyographic analysis of stomatognathic muscles in elderly after hippotherapy. Plos One 2020;15(8):e0238036. doi: 10.1371/journal.pone.0238036

14. Izuno H, Hori K, Sawada M. Physical fitness and oral function in community-dwelling older people: a pilot study. Gerodontology 2016;33(4):470-9. doi: 10.1111/ger.12186

15. Morita K, Tsuka H, Kimura H. Oral function and vertical jump height among healthy older people in Japan. Community Dent Health 2019;36(4):275-9. doi: 10.1922/CDH_4515Morita05

16. Fine AH, Andersen SJ. A Commentary on the Contemporary Issues Confronting Animal Assisted and Equine Assisted Interactions. J Equine Vet Sci 2021;100:103436. doi: 10.1016/j.jevs.2021.103436

17. Bos-Van Essen SM. [Equine Assisted Group Therapy. The effect on the quality of life in elderly with dementia. Tijdschr Gerontol Geriatr 2022;53(4). doi: 10.36613/tgg.1875-6832/2022.04.03

18. Wood WH, Fields BE. Hippotherapy: a systematic mapping review of peer-reviewed research, 1980 to 2018. Disabil Rehabil 2021;43(10):1463-87. doi: 10.1080/09638288.2019.1653997

19. Borges de Araujo T, Martins WR, Freitas MP, Camargos E, Mota J, Safons MP. An exploration of equine-assisted therapy to improve balance, functional capacity, and cognition in older adults with Alzheimer disease. J Geriatr Phys Ther 2019;42(3):155-60. doi: 10.1519/JPT.0000000000000167

20. Sylvia L, West E, Blackburn AM. Acceptability of an adjunct equine-assisted activities and therapies program for veterans with posttraumatic stress disorder and/or traumatic brain injury. J Integrative Med 2020;18(2):169-73. doi: 10.1016/j.joim.2020.01.005

21. Badin L, Alibran É, Pothier K, Bailly N. Effects of equine-assisted interventions on older adults' health: A systematic review. Int J Nurs Sci 2022;9(4):542-52. doi: 10.1016/j.ijnss.2022.09.008

22. Hilliere C, Collado-Mateo D, Villafaina S, Duque-Fonseca P, Parraça JA. Benefits of hippotherapy and horse riding simulation exercise on healthy older adults: a systematic review. PM R. 2018;10(10):1062-72. doi: 10.1016/j.pmrj.2018.03.019

23. Righetti MA, Taube OLS, Palinkas M. Osteoarthrosis: Analyze of the molar bite force, thickness and masticatory efficiency. Prague Med Rep 2020;121(2):87-95. doi: 10.14712/23362936.2020.7

24. Donizetti Verri E, Silva GP, Marianetti Fioco E. Effects of Parkinson's disease on molar bite force, electromyographic activity and muscle thickness of the masseter, temporal and sternocleidomastoid muscles: a case-control study. J Oral Rehabil 2019;46(10):912-9. doi: 10.1111/joor.12824

25. de Oliveira RH, Hallak JEC, Siéssere S, et al. Electromyographic analysis of masseter and temporal muscles, bite force, masticatory efficiency in medicated individuals with schizophrenia and mood disorders compared with healthy controls. J Oral Rehabil 2014;41(6):399-408. doi: 10.1111/joor.12164

26. Lopes RFT, Palinkas M, Pádua da Silva G. Stroke: An electromyographic approach to the masseter and temporal muscles, orofacial soft tissue pressure, and occlusal force. PLoS One 2023;18(3):e0282362. doi: 10.1371/journal.pone.0282362

27. Cerna M, Ferreira R, Zaror C, Navarro P, Sandoval P. Validity and reliability of the T-Scan(®) III for measuring force under laboratory conditions. J Oral Rehabil 2015;42(7):544-51. doi: 10.1111/joor.12284

28. Syed I, Joshi A, Desai AK, Anehosur V. Occlusal Analysis Using T-Scan in Patients With Condylar Fractures When Managed by Closed Method. J Craniofac Surg 2020;31(5):451-9. doi: 10.1097/SCS.0000000000006449

29. Fleck MP, Chachamovich E, Trentini C. Desenvolvimento e validação da versão em Português do módulo WHOQOL-OLD. Rev Saúde Pública 2006;40(5):785-91. doi: 10.1590/S0034-89102006000600007

30. Cohen J. A power primer. Psychol Bull 1992;112(1):155-9. doi: 10.1037//0033-2909.112.1.155

31. Miquel S, Aspiras M, Day JEL. Does reduced mastication influence cognitive and systemic health during aging? Physiol Behav 2018;188:239-50. doi: 10.1016/j.physbeh.2018.02.018

32. Cordes T, Bischoff LL, Schoene D. A multicomponent exercise intervention to improve physical functioning, cognition and psychosocial well-being in elderly nursing home residents: a study protocol of a randomized controlled trial in the PROCARE (prevention and occupational health in long-term care) project. BMC Geriatr 2019;19(1):369. doi: 10.1186/s12877-019-1386-6

33. Almotairy N, Kumar A, Trulsson M, Grigoriadis A. Development of the jaw sensorimotor control and chewing: a systematic review. Physiol Behav 2018;194:456-65. doi: 10.1016/j.physbeh.2018.06.037

34. da Silva N, Verri E, Palinkas M, Hallak J, Regalo S, Siéssere S. Impact of Parkinson's disease on the efficiency of masticatory cycles: Electromyographic analysis. Med Oral Patol Oral Cir Bucal 2019;24(3):314-8. doi: 10.4317/medoral.22841

35. Palinkas M, Marin NY, Bataglion C, et al. Severity of Sleep Bruxism and its Implications for the Stomatognathic System in Healthy Subjects. Open Access Macedonian J Med Sci 2020;8:29-35. doi: 10.3889/oamjms.2020.3727

36. Palinkas M, Borges TF, Junior MT. Alterations in masticatory cycle efficiency and bite force in individuals with periodontitis. Int J Health Sci (Qassim) 2019;13(1):25-9.

37. Throckmorton GS, Rasmussen J, Caloss R. Calibration of T-Scan sensors for recording bite forces in denture patients. J Oral Rehabil 2009;36(9):636-43. doi: 10.1111/j.1365-2842.2009.01978.x

38. Ayuso-Montero R, Mariano-Hernandez Y, Khoury-Ribas L, Rovira-Lastra B, Willaert E, Martinez-Gomis J. Reliability and Validity of T-scan and 3D Intraoral Scanning for Measuring the Occlusal Contact Area. J Prosthodont 2020;29(1):19-25. doi: 10.1111/jopr.13096

39. Donaldson MC, Holter AM, Neuhoff S. The translation of movement from the equine to rider with relevance for hippotherapy. J Equine Vet Sci 2019;77:125-31. doi: 10.1016/j.jevs.2019.02.017

40. de Mello EC, Diniz LH, Lage JB, Ribeiro MF, Bevilacqua Junior DE, Rosa RC, et al. Analysis of trunk neuromuscular activation during equine-assisted therapy in older adults. Percept Mot Skills 2022;129(5):1458-76. doi:10.1177/00315125221112249

41. Diniz LH, de Mello EC, Ribeiro MF. Impact of hippotherapy for balance improvement and flexibility in elderly people. J. Bodywork Mov Ther 2020;24(2):92-7. doi: 10.1016/j.jbmt.2019.10.002

42. Rigby BR, Davis RW, Bittner MD. Changes in motor skill proficiency after equine-assisted activities and brain-building tasks in youth with neurodevelopmental disorders. Front Vet Sci 2020;7:22. doi: 10.3389/fvets.2020.00022

43. Valle LMO, Nishimori AY, Nemr K. Atuação fonoaudiológica na equoterapia. Rev CEFAC 2014;16(2):511-23. doi:10.1590/1982-0216201420712

44. Hopper SI, Murray SL, Ferrara LR, Singleton JK. Effectiveness of diaphragmatic breathing for reducing physiological and psychological stress in adults: a quantitative systematic review. JBI Database System Rev Implement Rep 2019;17(9):1855-76. doi: 10.11124/JBISRIR-2017-003848

45. Menor-Rodríguez MJ, Sevilla Martín M, Sánchez-García JC, Montiel-Troya M, Cortés-Martín J, Rodríguez-Blanque R. Role and effects of hippotherapy in the treatment of children with cerebral palsy: a systematic review of the literature. J Clin Med 2021;10(12):2589. doi: 10.3390/jcm10122589

46. Ingrand I, Paccalin M, Liuu E, Gil R, Ingrand P. Positive perception of aging is a key predictor of quality-of-life in aging people. Plos One 2018;13(10):e0204044. doi: 10.1371/journal.pone.0204044

47. Fields B, Bruemmer J, Gloeckner G, Wood W. Influence of an equine-assisted activities program on dementia-specific quality of life. Am J Alzheimers Dis Other Demen 2018;33(5):309-17. doi: 10.1177/1533317518772052

48. Muñoz-Lasa S, López de Silanes C, Atín-Arratibel MÁ, Bravo-Llatas C, Pastor-Jimeno S, Máximo-Bocanegra N. Effects of hippotherapy in multiple sclerosis: pilot study on quality of life, spasticity, gait, pelvic floor, depression and fatigue. Med Clin (Barc) 2019;152(2):55-8. doi: 10.1016/j.medcli.2018.02.015