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Original Article

Lower limb balance, ankle dorsiflexion, orofacial tissue pressure, and occlusal force of rugby players

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A R T I C L E I N F O

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A B S T R A C T

This cross-sectional study examined the lower limb balance, ankle dorsiflexion, orofacial tissue pressure, and occlusal strength of rugby players. Twenty-six participants were divided into groups: rugby players ($n = 13$) and healthy sedentary adults ($n = 13$). Participants underwent an analysis of lower limb balance using a composite score (Y-Balance Test). Ankle dorsiflexion was measured using the Lunge Test. The Iowa Oral Performance Instrument was employed to measure orofacial tissue pressure. Bite force was measured with a dynamometer, and T-Scan assessed occlusal contact distribution. Data were analyzed using the *t*-test ($p < 0.05$) and ANCOVA with age and weight as covariates, where it is possible to verify that these factors did not influence the results obtained. Significant differences were observed in the balance of the right ($p = 0.07$) and left ($p = 0.02$) lower limbs, where rugby players had lower composite scores. There were significant differences in the right ($p = 0.005$) and left ($p = 0.004$) lunges, with rugby players showing lower values, as well as lower tongue pressure ($p = 0.01$) and higher lip pressure ($p = 0.03$), with significant differences to sedentary participants. There was no significant difference in molar bite force and distribution occlusal contacts between groups. Rugby seems to reduce lower limb displacement, cause ankle hypomobility, lead to changes in orofacial tissues, particularly the tongue and lips. This study is significant for identifying significant differences between rugby players and sedentary individuals, providing new insights into the impact of rugby on health and performance, which can benefit sports training and injury prevention.

1. Introduction

Rugby is a sport practiced in more than 120 countries. It comprises two teams, each with 15 players and seven substitutes, whose purpose is to take the ball to the opposing team's in-goal zone, either carrying it with their hands, kicking it forward, or passing it sideways or backward.[1] Its main feature is the strong physical interaction between players, with numerous contact and collision events during each game.[2]

Physical contact during matches is responsible for the largest proportion of injuries, mainly to the head and neck, and may involve ligaments, muscles, tendons, or the peripheral nervous system.[3] Rugby players do not use helmets as protective equipment despite the incidence rate of upper extremity injuries in this sport being 9.84 injuries per 1 000 athletic exposures.[4,5] Studies have indicated that depending on the degree of injury, soft tissue lacerations, mandible or malar bone fractures, tooth dislocation, temporomandibular joint injury, and neurological trauma may occur.[6,7]

The postural chain plays a fundamental role in the physical performance of rugby athletes, considering that the maintenance of incorrect postures and inappropriate sporting movements can promote greater energy expenditure and decrease the performance of skeletal striated muscles.[8] Functional alterations in anatomical structures that participate in the dynamic processes of sports, such as the spine, shoulder girdle, and neuromuscular system, can influence the appearance of disorders in the human body, such as changes in the mobility of muscle chains.[9–11]

Possible dysfunctions and imbalances in the muscular system of rugby athletes due to the movements performed and impacts during the game may present alterations in the stomatognathic system and the stabilizing musculature of the shoulder girdle. Therefore, this study aimed to

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Abbreviations

CEP/CONEP	Research Committee / National Commission for Research Ethics
CG	control group
cm	centimeters
IBM SPSS	International Business Machines Statistical Package for the Social Science
kPa	kilopascals
N	Newtons
RG	rugby players group
%	percentage

evaluate the balance of the lower limbs, ankle dorsiflexion, orofacial tissue pressure, and occlusal strength of rugby players.

The null hypothesis of this study was that rugby players would not have morphofunctional alterations in the stomatognathic system (soft tissue pressure, distribution of occlusal contact points, and molar bite force) or lower limbs (legs and ankles).

2. Methods

2.1. Ethical approval and sample

All procedures in this cross-sectional study were performed in accordance with the ethical standards of the CEP/CONEP System and approved by the Ethics Committee of the Faculty of Dentistry of Ribeirão Preto, University of São Paulo, Brazil (process # 58616322.8.0000.5419). An informed consent form was signed by all participants.

A convenience sample of male participants aged between 18 and 35 years old was distributed into two distinct groups: rugby players (RG; mean age ± standard deviation, [22.6 ± 1.4] years; $n = 13$) and healthy sedentary adults (CG; mean age ± standard deviation, [29.0 ± 3.3] years; $n = 13$). The anthropometric characteristics (mean ± standard error) of the two groups were as follows: RG (weight: [102.66 ± 6.17] kg; height: [1.81 ± 0.01] m) and CG (weight: [79.19 ± 3. 26] kg; height: [1.79 ± 0.02] m). The control group did not engage in any physical activity.

The post hoc sample size (*t*-test) was calculated using G*Power version 3.0.10 software (Franz Faul, Kiel University, Kiel, Germany) based on a 5 % error ($\alpha = 0.05$), test power of 81 % and effect size of 1.02 for the primary outcome of tongue pressure. The values used (mean ± standard deviation) to determine the representativeness of the sample composed of 13 participants in each group were the following: GR (59.69 ± 16.70) and CG (43.23 ± 15.50).

The inclusion criteria were as follows: natural dentition, normal occlusion, presence of the first four permanent molars, no temporomandibular disorder, no presence of other pathologies that compromise the musculature of the stomatognathic system, and being in the pre-established age range. Participants with ulcerations, open wounds or skin hypersensitivity, cognitive impairment, other neurological and systemic pathologies (decompensated), periodontal disease, orthodontic treatment, speech therapy, or otorhinolaryngological treatment were considered ineligible.

Rugby players trained twice weekly on gymnasium equipment to strengthen their muscles. Only one calibrated researcher collected the sample data. Personal protective equipment such as gloves for procedures, caps, masks, and disposable lab coats were used throughout the data collection process.

2.2. Stability of the lower limbs analysis

The Y-Balance Test was used to analyze dynamic postural control of the lower limbs.[12] The participants were positioned in orthostatism, with the anterior face of their body directed toward an anterior tape with their hands resting on their hips and their lower limb supported in the center of the "Y" and contralateral lower limb positioned to the left or right side of the center of the "Y" so that they remained in unipodal support.

From this position, the participants were asked to maintain their lower support limb in the center of the "Y" while performing maximum reach movements with the contralateral limb. These movements consisted of pushing the rectangular blocks of the device in three directions: anterior, posterolateral, and posteromedial. During this test, only dorsiflexion, knee flexion, and hip flexion of the support limb were allowed to obtain the maximum reach distance.

The distance was measured using a measuring tape inserted between the edges of the central and mobilized blocks. The heel was not allowed to be lifted from the support base, and the hands were removed from the hip during movement. In addition, the return to the initial position after the attempt without the occurrence of falls was considered a criterion for determining whether the attempt was valid. If any action contrary to the above rules was performed, the attempt would be considered a failure, and the test would need to be repeated.[13]

Initially, a protocol for warm-up, learning, and familiarization with the test was performed, which consisted of six attempts in all three directions, bilaterally divided into two blocks of three attempts in the presented directions, followed by a 5 min interval.

After the warm-up period, three bilateral attempts were made in each direction to obtain the maximum reach distance. For normalization, the length of the lower limbs of the participants was measured according to the distance between the anterior superior iliac spine and the medial malleolus using a measuring tape. To express the reach values as a percentage of limb length, the composite score was calculated using the following mathematical formula: sum of the highest values of the three reach directions divided by three times the length of the limbs and then multiplied by 100.[14]

2.3. Ankle dorsiflexion analysis

The Dorsiflexion Lunge Test was used to determine the dorsiflexion range of motion of the ankle joint in a position where the participant's own weight was able to exert pressure on this joint.[15,16] A line was drawn on the floor perpendicular to the wall to indicate where the measurements should be taken. The participants positioned both hands behind their back and then positioned the evaluated lower limb with the second toe in the center of the measuring tape, initially at the 10 cm mark, while the contralateral limb was positioned posterior to the tape to provide a stable base of support.

All participants were asked to lean forward to touch their knee on the wall while keeping the heel of the lower limb being assessed in contact with the ground. This procedure was performed until maximum stretch was felt in the posterior region of the calf, making it impossible to reach the goal.

The maximum distance at which the subject was able to complete the goal of touching the wall with their knee after the inclination was used. The test was performed bilaterally until the maximum distance from the wall was obtained, with 10 seconds (s) of rest between attempts. No preconditioning stretching or warm-up protocols were performed prior to the testing.

2.4. Pressure of orofacial tissues evaluation

The maximum pressure on the tongue, lips, buccinator, and orbicularis oris muscles was evaluated using the Iowa Oral Pressure Instrument (IOPI, model 2.3, IOPI Medical, Redmont, WA, USA). This instrument consists of a plastic bulb 3.5 cm long, filled with air, and connected to a pressure transducer through an 11.5 cm plastic tube.[17–19]

To measure tongue pressure, the participants were instructed to raise their tongue and squeeze the plastic bulb against the hard palate with maximum pressure for 3 s. To analyze lip pressure, the plastic bulb was positioned between the lips in maximum voluntary isometric contraction, and the subject was instructed to keep their teeth touching and press the bulb with their lips for 3 s. To check the pressure of the buccinator muscles (right and left sides), the plastic bulb was positioned internally between the jugal mucosa and the buccal surface of the posterior teeth, and the subject performed a suction movement. To evaluate the pressure on the orbicularis oris muscle, the plastic bulb was positioned internally near the external corner of the mouth, and the subject was asked to perform a suction movement.

The highest-pressure values in the clinical conditions were considered through the three measurements established during data collection. The Iowa Oral Pressure Instrument calibration was checked weekly according to the manufacturer's instructions to ensure the reliability of the results.

2.5. Molar bite force analysis

The maximum molar bite force was recorded using a digital dynamometer (model IDDK; Kratos, Cotia, SP, Brazil) adapted to oral conditions.[20,21] The maximum force measurements were performed in the region of the first permanent molar (right and left). During data collection, the participants remained seated in a comfortable chair, with their arms extended along their bodies and their hands resting on their thighs. They were instructed and trained to tighten the dynamometer rods, thus ensuring the reliability of the procedure.

For each collection, the dynamometer was cleaned with alcohol and protected using disposable latex fingers (Wariper-SP) positioned on the bite rods of the device as a biosafety measure. The protocol for the analysis of the maximum molar bite force consisted of three measurements on each side (right and left), with a 2 min interval between each measurement.

2.6. Distribution of the occlusal contacts

An analysis of the occlusal contact of the right and left hemiarches (upper and lower) and of the first permanent molars (upper and lower) in terms of percentage force was performed using the T-Scan® III Occlusal Analysis System (Tekscan, Inc. South Boston, MA. USA).[22]

The participants were asked to sit upright in a comfortable chair. The sensor was inserted into the oral cavity so that the positional guide, located on the support, was centralized and fitted between the upper central incisors. A tooth-clenching test was performed to determine the repetitive contact pattern. Each subject was instructed to press their teeth against the sensor while maintaining maximum voluntary isometric contraction. Values were considered acceptable if they reached a percentage between 95 and 100.

2.7. Statistical analysis

A descriptive analysis of the results was performed by calculating the means and standard errors. Subsequently, adherence to the parametric distribution was verified using the Shapiro-Wilk test. Data were analyzed using Statistical Package for the Social Science version 26.0 (IBM SPSS Inc., Chicago, IL, USA). The independent *t*-test and ANCOVA with age and weight as covariates were used for the comparison of the groups. ANCOVA showed an effect on covariates. Statistical significance was set at p-value < 0.05.

3. Results

With age and weight controlled for, ANCOVA revealed significant differences between the groups on the balance, orofacial and occlusal measures. Table 1 shows the balance of the lower limbs (right and left sides) and ankle dorsiflexion between the RG and CG. Significant differences were observed in the balance of the right ($p = 0.07$) and left ($p = 0.02$) lower limbs, where the RG had lower composite scores. There were significant differences in the right ($p = 0.005$) and left ($p = 0.004$) lunges, with RG showing lower values.

Table 1
Comparing the study groups based on the composite score in percentage (%) and ankle dorsiflexion in centimeters (cm) related to the lower limbs.

Variables	Groups		*p*-value
	Rugby Players Mean ± (*SE*[c])	Healthy Sedentary Mean ± (*SE*[c])	
Composite Score (%)			
Right leg	67.37 ± 2.19	84.50 ± 1.49	0.001[a]
Right leg	96.61 ± 1.76	102.26 ± 1.76	0.07[b]
Left leg	67.84 ± 2.66	84.34 ± 1.41	0.001[a]
Left leg	95.64 ± 1.76	102.89 ± 1.76	0.02[b]
Ankle dorsiflexion (cm)			
Right	8.53 ± 0,61	11.07 ± 0.75	0.01[a]
Right	7.42 ± 0.89	12.19 ± 0.89	0.005[b]
Left	7.51 ± 0.72	10.69 ± 0.68	0.004[a]
Left	6.53 ± 0.93	11.67 ± 0.93	0.004[b]

[a] Independent-samples *t*-test.
[b] ANCOVA with adjusting the baseline value.
[c] Standard Error.

The pressure on the orofacial tissues (tongue, lips, buccinator, and orbicularis oris muscles), distribution of occlusal contacts, and maximum bite force between the RG and CG are presented in Table 2. The RG showed significantly lower tongue pressure ($p = 0.01$) and higher lip pressure ($p = 0.03$). There were no significant differences in the maximum molar bite force and distribution of occlusal contacts between RG and CG.

4. Discussion

The null hypothesis of this study was rejected because rugby players showed significant functional alterations in the lower limbs and orofacial tissues, especially the tongue and lips when compared with the healthy sedentary adults group.

With possible dysfunctions and imbalances in the muscular system of rugby practitioners due to the movements performed and bodily impacts during the sport, functional alterations may occur in the stomatognathic system and the stabilizing musculature of the shoulder girdle.[23,24] These factors are important for studies that evaluate the human body of these practitioners to establish functional standards that can help promote their quality of life and well-being, contributing to a more effective and safe sport.

Postural control refers to a subject's ability to coordinate the body with an influence on motor tasks during daily activities.[25] In this study, the dynamic postural control of the lower limbs of all participants was analyzed using the Y-Balance Test, which can identify the risk of injuries to the lower limbs.[12,26] Significant differences were observed in the lower limbs (right and left) of the RG, where a composite score of approximately 96% was determined for both lower limbs, which was lower than that of the CG.

The Y-Balance Test presents different reference values according to the sport practiced and the sex of the evaluated subject. However, no data on the Y-Balance Test in relation to rugby was found in the literature. Therefore, reference values of similar sports were considered for comparison, such as American football, which presents a composite score between 87 % and 89 % as a reference, and results below these values are considered a high risk for the development of injuries in the lower extremities and hypomobility in the ankle or knee joints.[27]

In this study, ankle dorsiflexion was evaluated using the Lunge Test. The CG followed normal standards, while the RG presented hypomobility of the ankle joint due to the values obtained for both the right ankle (7.42 cm) and left ankle (6.53 cm), with significant differences between the groups.

The pattern that determines the functional change for this variable is related to body weight support, where the foot is perpendicular to a wall

Table 2
Comparison of study groups with respect to variables related to the stomatognathic system: molar bite force in Newtons (N), orofacial tissues in kilopascals (kPa), and occlusal contacts as a percentage (%).

Variables	Groups		p-value
	Rugby Players Mean ± (SE[c])	Healthy Sedentary Mean ± (SE[c])	
Molar bite force (N)			
Right	738.3 ± 67.0	654.5 ± 76.3	0.41[a]
Right	700.1 ± 98.9	692.1 ± 107.4	0.96[b]
Left	754.1 ± 64.7	735.1 ± 97.1	0.87[a]
Left	771.7 ± 114.4	716.7 ± 114.3	0.78[b]
Orofacial tissues (kPa)			
Tongue	43.23 ± 4.30	59.69 ± 4.63	0.01[a]
Tongue	41.14 ± 5.03	63.62 ± 5.03	0.01[b]
Lips	22.84 ± 2.66	12.84 ± 1.55	0.003[a]
Lips	23.77 ± 3.01	11.91 ± 3.01	0.03[b]
Right buccinator muscle	21.53 ± 1.29	18.53 ± 3.18	0.39[a]
Right buccinator muscle	21.00 ± 3.28	19.07 ± 3.28	0.73[b]
Left buccinator muscle	19.92 ± 1.90	19.23 ± 3.00	0.84[a]
Left buccinator muscle	22.22 ± 3.32	17.69 ± 3.32	0.43[b]
Right orbicularis oris muscle	26.92 ± 2.08	23.76 ± 2.81	0.37[a]
Right orbicularis oris muscle	26.84 ± 3.30	23.84 ± 3.30	0.60[b]
Left orbicularis oris muscle	27.53 ± 2.15	24.69 ± 2.50	0.39[a]
Left orbicularis oris muscle	27.17 ± 3.14	25.05 ± 3.14	0.69[b]
Occlusal Contacts (%)			
Right hemiarch	44.34 ± 2.36	50.62 ± 2.33	0.07[a]
Right hemiarch	46.98 ± 3.15	47.98 ± 3.15	0.85[b]
Left hemiarch	49.37 ± 2.33	55.66 ± 2.36	0.07[a]
Left hemiarch	52.01 ± 3.15	53.02 ± 3.15	0.85[b]
Tooth 16	10.60 ± 0.75	13.59 ± 1.02	0.02[a]
Tooth 16	11.66 ± 1.20	12.53 ± 1.20	0.67[b]
Tooth 26	11.37 ± 1.46	14.03 ± 1.63	0.23[a]
Tooth 26	12.11 ± 2.13	13.29 ± 2.13	0.75[b]
Tooth 36	10.84 ± 1.93	12.89 ± 1.26	0.38[a]
Tooth 36	11.16 ± 2.26	12.57 ± 2.26	0.72[b]
Tooth 46	10.99 ± 1.68	10.71 ± 1.30	0.89[a]
Tooth 46	9.84 ± 2.06	11.86 ± 2.06	0.57[b]

[a] Independent-samples *t*-test.
[b] ANCOVA with adjusting the baseline value.
[c] Standard Error.

and pushes the knee toward this obstacle. The distance between the foot and the wall was measured, and values smaller than 9–10 cm were considered restricted movements.[15] Research reports that amateur rugby players experience increased injury processes in the lower limbs, specifically in the knees and ankles, during games and training due to collisions.[28]

Another important factor in explaining ankle hypomobility in rugby players is the response of the medial and lateral gastrocnemius muscles, followed by the soleus during quick changes of direction, in which they need a longer return period. These muscles promote movements associated with flexion and braking of the ankle extension, assisting in knee flexion movement during the running process.[29] Due to the high demand on the calf muscles, functional alterations may occur in the musculature involved in the movement of adjacent anatomical structures.[30]

This study also analyzed the stomatognathic system of amateur rugby players. This system is composed of static and dynamic anatomical structures integrated with the neuromuscular responses of the human body that has a direct impact on the physical performance of sports practitioners.[24] The opposite statement may also be true, where structures that make up the human body when stimulated by sports can interfere with the functionality of the stomatognathic system owing to the interaction of this complex stomatognathic system with the musculoskeletal system.[31]

Mechanical stress and the maintenance of incorrect postural tone produced by rugby practice promote high nociceptive stimulation in several muscle groups, causing spasticity in some muscles and influencing the distribution of tension throughout the body.[32] This distribution could explain the results obtained for the pressure of the orofacial tissues, where the RG showed lower pressure on the tongue and greater pressure on the lips, with significant differences compared to the CG.

An important hypothesis observed in participants who practice rugby is an increase in body mass, which could influence the function of the stomatognathic system. This body enlargement may be related to sleep disorders, such as obstructive sleep apnea.[33] studies have reported that obstructive sleep apnea modifies the function of the stomatognathic system due to the mouth breathing pattern and muscle hypotonia.[34] This may explain the lower tongue pressures in the RG. In the present study, the presence of sleep disorders was not evaluated in either group. Physical exercise can increase serotonergic activity, which reduces muscle performance owing to its effects on behavior and motor control. Impact sports cause an increase in serotonin levels in the human body, which is a predictive factor for the onset of muscle fatigue.[35] This clinical situation could be another explanation for the lower tongue pressure in the RG.

The maintenance of body posture due to external factors such as sports activity requires the central nervous system to use compensatory adjustments to restore the balance of an anatomical structure through muscle activation.[36] The greater pressure on the lips in the RG may be related to the lower pressure on the tongue, demonstrating a muscular compensatory action in the stomatognathic system so that it remains in balance and maintains the primordial functions of the human organism, such as phonation, mastication, and swallowing.

This study found no significant differences between the groups in terms of maximum molar bite force. However, a greater maximum molar bite force was clinically observed in the RG. Physiological responses could justify the strength of the RG because sports involving high-intensity running and physical collisions, such as tackles, demand adequate physical conditioning from practitioners as a result of maximal aerobic activity in relation to the metabolic factor with functional consequences in the skeletal striated musculature, thus increasing the body's strength.[37] This could also help explain the greater molar bite force found in the RG.

As for the distribution of occlusal contact points, the RG group exhibited a lower occlusal contact percentage on the hemiarch (both right and left) and teeth (16, 26, and 36) without any statistically significant differences. Dental occlusion is an important variable to be observed in practitioners of the sport because it influences functional performance, and it is known that having a stable occlusion is an advantage in sports.[38] Studies have reported a relationship between dental occlusion and sports, both when observing muscle strength and postural control.[39] This study intended to determine the occlusal characteristics of the first permanent molars of rugby players. The first permanent molars are needed for grinding or crushing food and are essential for dentition, dental development, and stable occlusion.[40]

This study has several limitations. Polysomnography to diagnose obstructive sleep apnea was not performed. The use of polysomnography would help confirm the possible interference of this sleep disorder in the orofacial tissue results. We did not measure the serotonin levels of the rugby players. However, we would expect the levels of this neurotransmitter to be increased in the bloodstream of rugby players. Determining the control group presented significant challenges. Rugby players are typically young, highly athletic, and possess substantial weight, primarily attributed to muscle mass rather than body fat. When contemplating the composition of our sample pairs, we recognized that if we had selected individuals with the same weight, they might have been classified as obese, potentially leading to results influenced by individuals' weight. Age and weight were not found to have any significant influence on the study. Our sample included a diverse range of young, healthy adults, including professional athletes and sedentary individuals. The authors acknowledged the potential for research bias and identified it as a study limitation.

5. Conclusion

The findings of this study suggest that rugby promotes smaller displacements of the lower limbs, hypomobility of the ankle, and functional alterations of the orofacial tissues, especially the tongue and lips, in addition to a smaller distribution of occlusal contact points on the first upper molars. This study is important because it provides new information about the physical and orofacial characteristics of rugby players. Our findings highlight the need for specific training to improve balance, ankle mobility, and oral health in these athletes. This can contribute to enhancing athletic performance, preventing injuries, and promoting the overall well-being of rugby players. Further studies need to be conducted to confirm these results, as it is important to be aware of the functional characteristics of this sports modality to improve functional performance.

Ethical approval statement

All procedures in this cross-sectional study adhered to the ethical standards set by the CEP/CONEP System and received approval from the Ethics Committee at the Faculty of Dentistry of Ribeirão Preto, University of São Paulo, Brazil (process # 58616322.8.0000.5419). Additionally, all participants provided signed informed consent forms.

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Submission statement

As corresponding author, I hereby state that the manuscript has not been published previously, that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere including electronically in the same form, in English or in any Other language, without the written consent of the copyright-holder.

Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Authors' contributions

Rafael R. Machado: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Marcelo Palinkas:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis. **Paulo B. de Vasconcelos:** Writing – review & editing, Investigation. **Sara Gollino:** Writing – review & editing, Investigation. **Veridiana W. Arnoni:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Marcos Vinicios R. Prandi:** Writing – review & editing, Methodology, Investigation. **Isabela H. Regalo:** Writing – review & editing, Methodology, Investigation. **Selma Siéssere:** Writing – original draft, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Simone C.H. Regalo:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Conflict of interest

RRM, MP, PBV, SG, VWA, MVP, IHR, SS and SCHR declare that they have no conflicts of interest relevant to the content of this review.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.smhs.2023.12.002.

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