

EFFECT OF SWIMMING AND RUNNING ON SEMINAL QUALITY

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ABSTRACT

Objective: To verify the effect of the physical activity the swimming and of the running, on a moderate form, on the seminal quality.

Methods: A cross-sectional study performed with healthy men practicing moderate physical activity. The seminal parameters of 39 men between the ages of 23 and 37 years were evaluated. The participants in this study belonged to three groups: the swimming group (G1), the running group (G2), and the control group (G3). The level of physical activity was evaluated by calculating the metabolic equivalents (METs), using the Compendium of Physical Activities (CPA) to identify the intensities. Seminal parameters of volume, concentration/ml, total concentration, progressive motility, total motility, and sperm morphology were evaluated according to the normal values recommended by the World Health Organization (WHO) (2010). The level of significance was $p < 0.05$. **Results:** The results did not show statistical differences between groups regarding semen volume, concentration/ml, total concentration, progressive motility and total motility. On the other hand, there is a statistical difference between the groups for sperm morphology. Besides, sperm morphology was below the 4% threshold established by WHO for the swimming and running group. **Conclusion:** We noticed that there are no differences in the seminal parameters of men who practice different sports modalities at a moderate level, however sperm morphology can be impaired with the practice of moderate physical activity.

Keywords: male infertility; seminal quality; physical activity; swimming; running.

INTRODUCTION

Semen quality and male fertility potential can be influenced by some risk factors like age, lifestyle, environmental factors, excessive alcoholic beverages consumption, medication, tobacco, stress, obesity, sedentary lifestyle, and also by the practice of physical activity (PA).¹⁻⁷ The last risk factor mentioned is especially important because the PA has become widely popular worldwide. The physical exercise is promoted as an alternative to health, to reduce stress and improve quality of life, and its effects are beneficial for different ages and genders.^{8,9} However, the performance of PA can lead to deleterious effects and, in some cases, irreversible effects, such as: physical stress, changes in homeostasis, muscle injuries and joint pathologies. In this context, it is important to be aware of the effect of sports on semen quality.

Nowadays, infertility has become a worldwide problem, with incidence around 8% to 15%. In about 50% of cases, the cause of infertility is male, which raises doubts about the link between PA and male reproductive health.^{10,11} This association was evaluated and evidenced by some studies in female athletes, especially in runners, where the results suggested that the practice of strenuous exercise has been associated with several disorders of the menstrual cycle, including pubertal delay, luteal phase defects, anovulation, and amenorrhea.¹² In men, where the results seem more controversial, some authors found a positive association between PA and the improvement of semen quality.^{1,3,4,13} On the other hand, other authors have found negative associations,^{6,14} in which the seminal quality is impaired due to the practice of PA. Some studies mention that there is no effect of PA on sperm quality.^{15,16} Despite the numerous advances in andrological knowledge observed in the last decade, the considerable influence of sports on the male fertility remains unknown,

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making evident the innumerable contradictions between studies that measure the fact that PA is good or not for male reproductive health.

It is worth discussing the fact that sports training cannot be easily quantified since it varies according to the intensity, volume, and different sports modalities. Regarding the variables related to PA, the intensity and the volume are extremely relevant on semen quality.¹⁷⁻¹⁹ When the overload is increased to an ideal level (moderate intensity), there seems to be a better response to the hormonal parameters and male reproductive health. On the other hand, when the overload imposed by exercise is too high, there may be a negative influence on seminal quality.^{11,17} Other inherent parameters related to PA mention that dysfunction in the reproductive system will depend on the sporting modality in question.^{20,21} However, the results vary widely, and more solid conclusions are expected²² in the search field in human reproduction.

Running and swimming are among the most popular forms of physical exercise. The practice of different sports activities, each one with its degree of impact, can result in differences in the seminal profiles of the practitioners. In this perspective, PA is seen as a powerful stimulator of the endocrine system, acting differently and according to the modality, and may cause changes in seminal quality.^{14,23} Thus, the objective of the present study is to verify the effect of swimming and running PA, moderately, on seminal quality, more specifically on volume, concentration/ml, total concentration, progressive motility, total motility, and morphology of spermatozoa.

METHODS

The present cross-sectional study performed during July 2018 and October 2019, counted on the voluntary participation of men, aged between 23 and 37 years old. All participants were naturalized Brazilians. The study was approved by the Research Ethics Committee of the University of Caxias do Sul, and all participants signed a free and informed consent form. The volunteers were also interviewed by a urologist doctor who filled out an epidemiological assessment form, where possible risk factors that could alter the quality of the semen were highlighted. The participants were recruited by one of the study researchers, who was responsible for going to gyms and sports clubs (with swimming and running activities) to invite the subjects to participate in the study. In the city of Caxias do Sul, the Rio Grande do Sul, Brazil, the subjects participants were recruited from three running groups and two swimming schools. The experiments had the presence of 39 men, who were included (or not) in the experimental design, according to the criteria below.

CRITERIA FOR INCLUSION AND EXCLUSION

The men participating in the study had to meet the following inclusion criteria: a) do not have a known medical condition that could interfere with seminal quality; b) perform moderate-intensity PA, one to five times a week, lasting at least 30 minutes a day; c) perform physical activity with a consumption of 20 to 40 METs-hours/week (swimming and running groups); d) perform physical activity with a consumption of 10 to 20 METs-hours/week (control group); e) be between 18 and 40 years of age.

The exclusion criteria adopted were as follows: a) the use of alcoholic beverages, drugs, cigarettes, anabolic or to use any type of medicines that can alter seminal quality; b) having undergone surgeries that may alter the seminal quality, such as scrotal surgery; c) having undergone chemotherapy or radiotherapy; d) being exposed to pesticides or paints that may impair seminal quality; e) being obese (body mass index (BMI) ≥ 30 kg/m²), sedentary, with diabetes, depression or any disease that may affect seminal quality; f) making use of antioxidants such as vitamin supplements, which can benefit seminal quality.

The 39 participants in this study belonged to three groups: 13 to swimming group (G1), 13 to running group (G2), and 13 to the control group (G3). The Participants' Classification Flowchart (Figure 1) was created to facilitate the analysis of individuals and the division performed in groups.

A seminal sample was collected from each participant, with a total of 39 samples for the study. No participant was excluded from this study.

The seminal parameters were analyzed according to the normal values recommended by the World Health Organization WHO,²⁴ and they are mentioned in Table 1.

The table of participants' morphofunctional characteristics and training (Table 2) was created to facilitate the exposure of the morphofunctional characteristics and the forms of training of groups 1, 2, and 3. Participants had a mean age of 29.7 years old (ranging from 23 to 33 years old), 88.4% had normal BMI (<25 kg/m²) and 11.6% were considered overweight (BMI between 25-29.9 kg/m²). The mean value of METs-h/week was 25.0 (22.7-27.3) (G1 and G2) and 16.7 (14.7-18.7) (G3), with G1 training at a mean of 2.7 h/week, G2 of 3.3 h/week and G3 1.0 h/week. The G1 participants practiced swimming an average of 3.7 years (2.4-5.0 years), whereas G2 participants practiced running on an average of 4.1 years (2.6-5.6 years). The G3 participants practiced physical activity in an average of 2.5 years (2.0-3.0 years). According to these data, it was possible to identify a significant difference between the groups in the value of METs-h/week, number of sessions/week, and duration of the training.

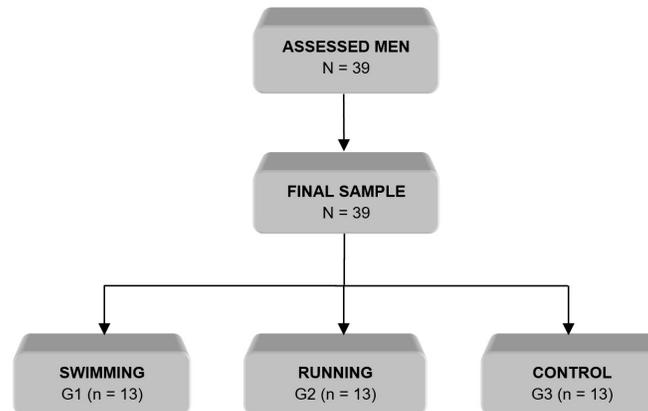


Figure 1 - Flowchart of classification of participants

Source: prepared by the author.

Table 1 - Normal values for seminal analysis parameters

SEMINAL PARAMETER	STANDARD VALUES
Volume	≥ 1.5 ml
pH	7.2-8.0
Color	Opaque white
Liquefaction	≤ 30 min, complete
Viscosity	Normal
Concentration/ml	≥ 15x10 ⁶ sperm per ml of semen
Total concentration	≥ 39x10 ⁶ spermatozoa by ejaculate
Progressive motility	≥ 32% with linear progression
Total motility	≥ 40%
Morphology	≥ 4% with normal shapes
Vitality	≥ 58% of living forms

Note: values stipulated according to the WHO parameters.²⁴

Table 2 - Morphofunctional characteristics and training of the participants

Parameters	G1 Swimming	G2 Running	G3 Control	p value ^d
N° of participants	13	13	13	
Level of training	Moderate	Moderate	Low	
Age (years)	29.5 ± 4.0	28.7 ± 3.8	31.0 ± 3.3	0.58
Weight (kg)	75.4 ± 9.8	77.5 ± 9.1	80.8 ± 9.3	0.59
Height (cm)	178.2 ± 6.6	179.6 ± 6.1	176.5 ± 6.4	0.58
BMI (kg/m ²)	23.7 ± 2.3	24.1 ± 1.9	25.9 ± 2.1	0.67
METs - h/week	32.0 ± 1.7 ^c	32.5 ± 2.9 ^c	16.7 ± 2.0 ^{a,b}	0.00
N° of sessions/week	3.3 ± 0.6 ^c	3.5 ± 0.8 ^c	1.8 ± 0.4 ^{a,b}	0.00
Duration of training (min)	49.6 ± 5.5 ^{b,c}	56.6 ± 4.4 ^{a,c}	30.2 ± 4.2 ^{a,b}	0.02
Training time (years)	3.7 ± 1.3	4.1 ± 1.5 ^c	2.5 ± 0.5 ^b	0.01

Values given as mean ± standard deviation.

^aSignificant difference (p < 0.05) compared to the swimming group.

^bSignificant difference (p < 0.05) compared to the running group.

^cSignificant difference (p < 0.05) compared to the control group.

^dAnalysis of variance (ANOVA).

INTENSITY EVALUATION OF THE PHYSICAL EXERCIS

The intensity of physical exercise was measured by calculating the METs hours of PA per week. Participants mentioned the duration of their training and the number of sessions in the last seven days. In order to estimate the total METs hours per week, we checked the METs of the PA of swimming, running, walking, and stretching, and calculated the average METs for each participant. We classified the moderate physical activity between 4 to 8 METs and the low physical activity between 2 to 4 METs. The Compendium of Physical Activities (CPA) proposed by Ainsworth et al.²⁵ was used to identify the intensities. Having the number of training sessions per week and the duration of the participants' training, we could calculate the number of hours of PA per week. Finally, we multiplied the mean of the METs by the total number of hours of PA per week.

MATERIAL SAMPLING AND COLLECTION

A seminal sample was collected by masturbation, between a period of 2 to 5 days of abstinence. After liquefaction, the seminal analysis was performed by the manual method. Morphology slides were about Tygerberg's written criterion.²⁶ The collections were carried out in an appropriate room destined for this purpose in Clinic Conception - Reproduction Human Center (Conception - Centro de Reprodução Humana).

MACROSCOPIC EVALUATION OF SEMEN

Seminal and spermatoc parameters were evaluated from 30 to 60 min after ejaculation at a temperature of 37°C, thus proceeding the seminal liquefaction before the sperm concentration and other parameters were evaluated. The macroscopic evaluation of the ejaculate fluid was carried out to evaluate the following aspects: color, volume, viscosity, and liquefaction. The ejaculate volume was measured by the entire sample aspiration using a graduated pipette coupled to an electronic pipettor.

CONCENTRATION DETERMINATION AND SPERM MOTILITY

After mixing completely the seminal material with the aid of a sample blender (vortex for 2 seconds to mix the sample), its pH was evaluated manually. For the determination of sperm concentration and motility a five microliter liquefied aliquot was inserted into a Makler counting chamber, with the use of a pressure pipette, until the filling was completed. These samples were manually analyzed by using an optical microscope equipped with a 20X phase contrast objective and a magnification of 200X.

SPERMATOZOON MORPHOLOGY DETERMINATION

According to the classification of Tygerberg's strict criteria,²⁶ a spermatozoon is considered normal when its head has an oval and perfect configuration, with a well-defined acrosome, covering about 40-70% of the spermatozoon cephalic portion. Heads with a border shape are considered abnormal. The length of the normal heads for stained spermatozoa is 5-6 µm and the width is 2.5-3.5 µm. There should be no abnormality in the middle piece or tail. The intermediate piece should be thin, attached to the central part of the body, and less than 1µm wide. Its length should be approximately one and a half times the length of the head measurement. The cytoplasmic inclusion may not be greater than half the cephalic portion of the spermatozoon, while the tail should be uniform, slightly thinner than the intermediate piece, approximately 45 µm, and may not be spiral.

Two smears of each sample were prepared on microscopy slides and then fixed and stained. The method used for the fixation depends on the staining technique to be applied. For the accomplishment of the present study, we used the Diff-Quick method of staining. After the slide had dried in the ambient air, it was identified with the patient's name, access number, and date. This slide was immersed in the Diff-Quick fixative solution (1.8 mg/L triaryl methane dye, 100% pyridinium dichromate in methyl alcohol) five times, followed by an interval of one-second between each immersion. After approximately 15 min, the slide was immersed in Diff-Quick Solution I (1 g/L dye xanthene 100% pyridinium dichromate, buffer, and sodium acid (0.01%)) three times for one second followed by an interval of one second. The excess dye was withdrawn and the slide was immediately immersed in Diff-Quick solution II [1.25 g/L thiazine dye, 100% pyridinium dichromate (0.625 g/L azure A and 0.625 g/L methylene blue)] by five times, followed by one second, with the interval of one second. The slide was washed in deionized water to remove any excess dye.

Using an ocular micrometer the spermatozoa were measured when there was doubt about damage as for its length or width. At least four areas of different fields were analyzed on each smear. The evaluation was done using the immersion objective lens with high-quality fluorescence anti-slip oil (1000X). The spermatozoa were classified as normal or abnormal. After analysis of the seminal quality, the biological material was discarded (eliminated).

The Seminal quality analysis Flowchart was elaborated (Figure 2) to facilitate the analysis of the procedures mentioned above, as well as to simplify the methodology for the seminal analysis in groups 1 and 2.

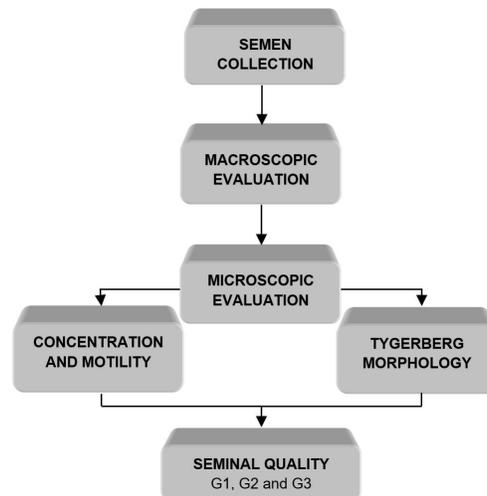


Figure 2 - Flowchart of seminal quality analysis

Source: prepared by the author.

SAMPLE CALCULATION

Based on the literature data, the sample calculation was performed through a pilot study containing six individuals from each group. Thus, the number of individuals required ($n = 13$) was identified to detect a minimum difference of 25 million in the total number of spermatozoa, and to achieve a statistical power of 90%. The G* Power program was used to calculate the statistical power version 3.1.4, written by Franz Faul (2012), of Kiel University, Germany.

STATISTICAL ANALYSIS

The mean and the standard deviation were calculated for the descriptive analysis of the continuous variables. The inferential analysis the normality of the data was tested through the Shapiro-Wilk test for all dependent variables. When normality was confirmed, the analysis of variance (ANOVA) was used to compare the groups for the descriptive variables. For all the tests it was adopted a $p < 0.05$.

RESULTS

The seminal parameters results are shown in Table 3. According to them, it is possible to observe that, compared to the swimming group (G1), the values were better for the running group (G2) for all seminal parameters. However, there was no significant difference between the groups. In the comparison of the control group with both groups (G1 and G2), there has been a significant difference the sperm morphology. In addition, the sperm morphology was below the WHO threshold of 4% for G1 and G2.

Table 3 - Seminal parameters of groups 1, 2, and 3

Parameters	G1 Swimming	G2 Running	G3 Control	p value ^d
Volume (ml)	2.2 ± 1.0	2.6 ± 1.7	3.4 ± 0.9	0.07
Concentration/ml (10 ⁶ /ml)	62.5 ± 38.1	91.3 ± 37.8	64.9 ± 32.6	0.11
Total concentration (10 ⁶)	124.5 ± 93.0	210.5 ± 92.8	211.8 ± 95.3	0.11
Progressive motility (%)	43.3 ± 23.9	53.8 ± 18.5	45.4 ± 12.5	0.37
Total motility (%)	63.1 ± 24.8	68.8 ± 16.7	63.3 ± 11.9	0.69
Morphology (%)	2.3 ± 0.9 ^c	3.3 ± 1.4 ^c	5.0 ± 0.7 ^{a,b}	0.02

Values given as mean ± standard deviation.

^aSignificant difference ($p < 0.05$) compared to the swimming group.

^bSignificant difference ($p < 0.05$) compared to the running group.

^cSignificant difference ($p < 0.05$) compared to the control group.

^dAnalysis of variance (ANOVA).

From these data, the means of the seminal parameters for G1, G2, and G3 were (2.2 ml; 2.6 ml; 3.4 ml) for the sperm volume, ($62.5 \times 10^6/\text{ml}$; $91.3 \times 10^6/\text{ml}$; $64.9 \times 10^6/\text{ml}$) for the concentration/ml, (124.5×10^6 ; 210.5×10^6 ; 211.8×10^6) for the total concentration, (43.3%; 53.8%; 45.4%) for progressive motility, (63.1%; 68.8%; 63.3%) for total motility, and (2.3%; 3.3%; 5.0%) for morphology, respectively.

Regarding the results of the participants' morphological and training characteristics (Table 2), the only parameter that resulted in the statistical difference between the groups (G1 and G2) was the duration of the training, with mean values of 49.6 min for the G1, and 56.6 min for the G2. In the comparison of the control group with the groups G1 and G2 there has been a significant difference in the value of METs-h/week, number of sessions/week, and duration of the training. The rest of the morphological characteristics showed a very close averages for groups G1, G2 and G3 (29.5 years; 28.7 years; 31.0 years) for age, (75.4 kg; 77.5 kg; 80.8 kg) for weight, (178.2 cm; 179.6 cm; 176.5 cm) for the height, ($24.1 \text{ kg}/\text{m}^2$; $23.7 \text{ kg}/\text{m}^2$; $25.9 \text{ kg}/\text{m}^2$) for the BMI.

DISCUSSION

Our data suggest that the means of the volume, concentration/ml, total concentration, progressive motility, and total motility seminal parameters in all groups are within the reference values prescribed by the WHO.²⁴ However, the spermatic morphology is below these values for G1 and G2. The results also suggest that there is a statistical difference in swimming and running practitioners having sperm morphology of lower quality compared to the control group. For other semen parameters, such as volume, concentration/ml, total concentration, progressive motility, and total motility, no clear relationships were found between the groups. Other physical parameters such as color, viscosity, liquefaction, pH, and vitality did not present relevant associations for the groups, being within the normal range.

The objective of our study was to evaluate the effect of moderate recreational physical activity on seminal quality, assuming that moderate physical activity could generate benefits for seminal quality. Data indicate that the practice of moderate PA can have a beneficial or neutral effect on male reproductive health.^{16,27,28} In this context, a large sample study (2,261 men) conducted by Wise et al.¹⁶ did not establish any association between regular (moderate) physical activity for any semen quality parameter. Besides a recent study by Ibañez-Perez et al.²⁸ suggests that moderate (≤ 2 h/week) and intense (> 2 h/week) running does not cause significant changes in semen quality in men of infertile couples. However, in our study we found low values for sperm morphology in both physical activities of moderate intensity. The evaluation of the spermatic morphology was made through Tygerberg's strict criteria,²⁶ where the mean values in both groups were below the established threshold (2.3% for G1 and 3.3% for G2). The relationship between moderate PA and low sperm morphology was unexpected, as we did not find this relationship in previous studies. It is important to note that although our results are not consistent with other studies' health.^{16,27,28} It should be noted that we do not compare moderate PA with a control group formed by sedentary people, but with a control group formed by healthy people practicing low-intensity physical activity, which could be the reason for the contradiction.

On the other hand, our results are in agreement with a study by Vaamonde et al.,²⁹ who compared three sports with different levels of training (physically active group, water polo, and triathlon). The results of this study showed that morphology was the most affected seminal parameter, resulting in a statistical difference and clinical relevance in the comparison between sports. Moreover, another study³⁰ reveals that sperm morphology was one of the parameters most affected by a cycling training program. From this perspective, when comparing different sports, there seems to be a greater effect on sperm morphology.

It is worth mentioning that when comparing our study data with other studies, a strong range of factors should be taken into accounts, such as the method for assessing PA intensity and the forms used for the analysis of semen. Increasingly, studies with a similar objective to ours report the lack of a standard for sperm analysis.^{3,11,17,19} Also, it should be emphasized that PA (as a variable) cannot be easily quantified due to the wide variety of exercises available. Considering these factors, in our study semen samples were analyzed according to 2010 WHO criteria.²⁵ To identify the intensity of the participants' physical activity, we performed the METs calculations. We emphasize that, although the duration of training had a significant difference between the G1 and G2, the modalities had the same level of training according to the METs-h/week values, fitting as moderate-intensity physical activities.

Interestingly, all values of the seminal parameters had better results for the running group compared to the swimming group. However, there was no statistical difference between the groups. In our study, swimming participants trained in semi-Olympic pools (25 meters) with a temperature of approximately 30°C (with a temperature range from 29°C to 31°C), where the water method purification was done through ozone treatment and the addition of chlorine, clarifier, algicides, pH lift, among other chemicals. Thus the differences observed in the swimmers' seminal profiles may be due to the inherent characteristics of their training, since exposures to chemical products and environmental factors may affect seminal quality.^{31,32} The same possibility was previously discussed by a study that investigated seminal parameters in

water polo players,²⁹ but such factors could or could not be directly related to the running group, once their training was performed outdoors. However, a further investigation of the environmental effect in these sports would be interesting.

As far as we know, our study comparing two sports modalities with moderate intensity is the only one available in the literature about the effect on seminal quality. We also believe to have the only study that analyzed seminal parameters of moderate swimming. Only two other studies analyzed swimming in men.^{30,33} These studies verified hormonal effects in elite swimmers, where the results seem contradictory. Nevertheless, the results of one of these studies³³ suggests that during short-term intensive training (4 weeks), norepinephrine urinary excretion was significantly lower in overtraining swimmers (overtraining syndrome) compared to well-trained swimmers. Therefore, excessive swimming training suggests the possibility of neuroendocrine changes, which may interfere in reproduction. Another study³⁴ analyzed the effect of forced swimming (3 min in the water at 32 °C for 15 days) in adult male rats, suggesting that the stress generated by swimming practice did not affect fertility, but significantly reduced sperm production, which could compromise seminal health.

In the field of research in human reproduction, much has been debated about the decline of semen quality over the years.^{35,36} A possible explanation for this fact could be the increase in sedentary behavior and obese people, resulting from the simultaneous decrease in the practice of PA. The sedentary lifestyle may be associated with poor semen quality and a sedentary lifestyle is related to poor sperm quality.³⁷ As an alternative for the treatment of seminal quality, the efficacy of moderate PA for seminal quality has been evidenced by several authors.^{1,13,38,39} Among them, a study carried out by Gaskins et al.³⁹ found that sperm concentration was 43% higher in men who undertook moderate physical exercise after seeking infertility treatment. This same hypothesis is defended by another study performed by,¹³ who verified the seminal quality of 1026 sedentary men, aged between 25 and 40 years old, and with more than one year of infertility. The results of this study provided information on the efficacy of moderate aerobic training as a treatment option for male infertility. Therefore, it is worth pointing out that, although our study did not compare sedentary subjects with swimmers and runners, we believe that most of the seminal parameters remained within the normal range because they were analyzed in physically active subjects.

Most of the studies related to different sports modalities to male fertility, speak about cycling as one of the main sports that can generate dysfunctions in the male reproductive system.^{21,40} This is due to the mechanical impact generated to the scrotum area with the bicycle seat, in addition to other factors, such as the use of tight clothing and gonadal overheating. However, in the case of the sports modalities surveyed (swimming and running), this fact is not evidenced, since the participants of both modalities had no impact to the scrotal area and used comfortable clothes in their training. In addition, the participants of this research reported not having made use of neither a type of supplement nor anabolic steroids, thus avoiding possible damages in seminal quality. Evidence indicates that male hypogonadism (difficulty in producing testosterone) may be caused by the use of anabolic steroids.⁴¹

Among the limitations of the present study is the difficulty of characterizing the exact level of physical activities studied. We recognize that none of the methods available to assess the level of physical activity is perfect.⁴² Another limiting fact is that only one seminal sample was collected for each individual, but there are limited advantages of using more than one semen sample per man in epidemiological studies.⁴³ It should be pointed out though, that the men studied were healthy and had no particular medical history that could influence their fertility potentials. Other issues related to male reproductive health could have been investigated, such as hormonal profiles and sperm DNA fragmentation.

CONCLUSION

The moderate practice of swimming and running were associated with normal semen parameters for volume, concentration/ml, total concentration, progressive motility, and total motility, however, the sperm morphology was below the WHO criteria. In the comparison of modalities, swimming was associated with lower values in all seminal parameters compared to running. However, there was no significant difference between the groups. In the comparison of the control group with both groups (G1 and G2), there has been a significant difference in the sperm morphology. The results suggest that there are no differences in the seminal parameters of men who practice different sports modalities of moderate-intensity, however sperm morphology can be impaired with the practice of moderate physical activity.

Our observation investigated only healthy, physically active men. As future ideas, we will discuss the possibilities of expanding our research with a larger samples, with another population, and with sedentary men who are starting swimming and running, thus verifying the effect of these modalities before and after a training period.

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REFERENCES

- Lalinde-Acevedo PC, Mayorga-Torres BJM, Agarwal A, du Plessis SS, Ahmad G, Cadavid AP, et al. Physically active men show better semen parameters than their sedentary counterparts. *Int J Fertil Steril*. 2017;11(3):156-65. PMID:28868837.
- Jurewicz J, Radwan M, Sobala W, Ligocka D, Radwan P, Bochenek M, et al. Lifestyle and semen quality: role of modifiable risk factors. *Syst Biol Reprod Med*. 2014;60(1):43-51. <http://dx.doi.org/10.3109/19396368.2013.840687>. PMID:24074254.
- Gaskins AJ, Mendiola J, Afeiche M, Jorgensen N, Swan SH, Chavarro JE. Physical activity and television watching in relation to semen quality in young men. *Br J Sports Med*. 2015;49(4):265-70. <http://dx.doi.org/10.1136/bjsports-2012-091644>. PMID:23380634.
- Pärn T, Grau Ruiz R, Kunovac Kallak T, Ruiz JR, Davey E, Hreinsson J, et al. Physical activity, fatness, educational level and snuff consumption as determinants of semen quality: findings of the ActiART study. *Reprod Biomed Online*. 2015;31(1):108-19. <http://dx.doi.org/10.1016/j.rbmo.2015.03.004>. PMID:25999214.
- Kikuchi H, Inoue S, Fukushima N, Takamiya T, Odagiri Y, Ohya Y, et al. Social participation among older adults not engaged in full- or part-time work is associated with more physical activity and less sedentary time. *Geriatr Gerontol Int*. 2017;17(11):1921-7. <http://dx.doi.org/10.1111/ggi.12995>. PMID:28230301.
- Eisenberg ML, Kim S, Chen Z, Sundaram R, Schisterman EF, Buck Louis GM. The relationship between male BMI and waist circumference on semen quality: data from the LIFE study. *Hum Reprod*. 2014;29(2):193-200. <http://dx.doi.org/10.1093/humrep/det428>. PMID:24306102.
- Niederberger C. Re: effects of work and life stress on semen quality. *J Urol*. 2015;193(2):626-7. <http://dx.doi.org/10.1016/j.juro.2014.11.047>. PMID:25617298.
- World Health Organization. Global recommendations on physical activity for health. Geneva: WHO; 2010.
- Guthold R, Louazani SA, Riley LM, Cowan MJ, Bovet P, Damasceno A, et al. Physical activity in 22 African countries: results from the World Health Organization STEPwise approach to chronic disease risk factor surveillance. *Am J Prev Med*. 2011;41(1):52-60. <http://dx.doi.org/10.1016/j.amepre.2011.03.008>. PMID:21665063.
- Du Plessis S, Kashou A, Vaamonde D, Agarwal A. Is there a link between exercise and male factor infertility. *Open Reprod Sci J*. 2011;3(1):105-13. <http://dx.doi.org/10.2174/1874255601103010105>.
- Józków P, Rossato M. The impact of intense exercise on semen quality. *Am J Men Health*. 2017;11(3):654-62. <http://dx.doi.org/10.1177/1557988316669045>. PMID:27645515.
- Prather H, Hunt D. Issues unique to the female runner. *Phys Med Rehabil Clin N Am*. 2005;16(3):691-709. <http://dx.doi.org/10.1016/j.pmr.2005.03.002>. PMID:16005400.
- Hajzadeh Maleki B, Tartibian B. Moderate aerobic exercise training for improving reproductive function in infertile patients: a randomized controlled trial. *Cytokine*. 2017;92:55-67. <http://dx.doi.org/10.1016/j.cyto.2017.01.007>. PMID:28092795.
- Vaamonde D, Da Silva-Grigoletto ME, Fernandez JM, Algar-Santacruz C, García-Manso JM. Findings on sperm alterations and DNA fragmentation, nutritional, hormonal and antioxidant status in an elite triathlete. Case report. *Rev Andal Med Deporte*. 2014;7(4):143-8. <http://dx.doi.org/10.1016/j.ramd.2014.07.001>.
- Mínguez-Alarcón L, Chavarro JE, Mendiola J, Gaskins AJ, Torres-Cantero AM. Physical activity is not related to semen quality in young healthy men. *Fertil Steril*. 2014;102(4):1103-9. <http://dx.doi.org/10.1016/j.fertnstert.2014.06.032>. PMID:25064411.
- Wise LA, Cramer DW, Hornstein MD, Ashby RK, Missmer SA. Physical activity and semen quality among men attending an infertility clinic. *Fertil Steril*. 2011;95(3):1025-30. <http://dx.doi.org/10.1016/j.fertnstert.2010.11.006>. PMID:21122845.
- Ibañez-Perez J, Santos-Zorroza B, Lopez-Lopez E, Matorras R, Garcia-Orad A. An update on the implication of physical activity on semen quality: a systematic review and meta-analysis. *Arch Gynecol Obstet*. 2019;299(4):901-21. <http://dx.doi.org/10.1007/s00404-019-05045-8>. PMID:30671700.
- Fernández-García JC. Running for your sperm; benefits of physical exercise on seminal quality. *Nutr Hosp*. 2017;34(3):503-4. PMID:28627181.
- Vaamonde D, Garcia-Manso JM, Hackney AC. Impact of physical activity and exercise on male reproductive potential: a new assessment questionnaire. *Rev Andal Med Deporte*. 2017;10(2):79-93. <http://dx.doi.org/10.1016/j.ramd.2016.11.017>. PMID:29657603.
- Denham J, O'Brien BJ, Harvey JT, Charchar FJ. Genome-wide sperm DNA methylation changes after 3 months of exercise training in humans. *Epigenomics*. 2015;7(5):717-31. <http://dx.doi.org/10.2217/epi.15.29>. PMID:25864559.
- Kipandula W, Lampiao F. Semen profiles of young men involved as bicycle taxi cyclists in Mangochi District, Malawi: A case-control study. *Malawi Med J*. 2015;27(4):151-3. PMID:26955437.

22. Gomes No M, Duraes AR, Conceicao LSR, Saquetto MB, Ellingsen O, Carvalho VO. High intensity interval training versus moderate intensity continuous training on exercise capacity and quality of life in patients with heart failure with reduced ejection fraction: a systematic review and meta-analysis. *Int J Cardiol.* 2018;261:134-41. <http://dx.doi.org/10.1016/j.ijcard.2018.02.076>. PMID:29572084.
23. Vaamonde D, Silva-Grigoletto ME, Garcia-Manso JM, Barrera N, Vaamonde-Lemos R. Physically active men show better semen parameters and hormone values than sedentary men. *Eur J Appl Physiol.* 2012;112(9):3267-73. <http://dx.doi.org/10.1007/s00421-011-2304-6>. PMID:22234399.
24. Cooper TG, Noonan E, von Eckardstein S, Auger J, Baker HW, Behre HM, et al. World Health Organization reference values for human semen characteristics. *Hum Reprod Update.* 2010;16(3):231-45. <http://dx.doi.org/10.1093/humupd/dmp048>. PMID:19934213.
25. Ainsworth B, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc.* 2000;32(9, Suppl):S498-504. <http://dx.doi.org/10.1097/00005768-200009001-00009>. PMID:10993420.
26. Menkveld R, Kruger TF. Advantages of strict (Tygerberg) criteria for evaluation of sperm morphology. *Int J Androl.* 1995;18(2, Suppl 2):36-42. PMID:8719857.
27. Safarinejad MR, Azma K, Kolahi AA. The effects of intensive, long-term treadmill running on reproductive hormones, hypothalamus-pituitary-testis axis, and semen quality: a randomized controlled study. *J Endocrinol.* 2009;200(3):259-71. <http://dx.doi.org/10.1677/JOE-08-0477>. PMID:19066291.
28. Ibañez-Perez J, Santos-Zorroza B, Lopez-Lopez E, Irazusta J, Prieto B, Aparicio V, et al. Impact of physical activity on semen quality among men from infertile couples. *Eur J Obstet Gynecol Reprod Biol.* 2019;237:170-4. <http://dx.doi.org/10.1016/j.ejogrb.2019.04.024>. PMID:31063967.
29. Vaamonde D, Silva-Grigoletto ME, Garcia-Manso JM, Vaamonde-Lemos R, Swanson RJ, Oehninger SC. Response of semen parameters to three training modalities. *Fertil Steril.* 2009;92(6):1941-6. <http://dx.doi.org/10.1016/j.fertnstert.2008.09.010>. PMID:19013565.
30. Bonifazi M, Bela E, Carli G, Lodi L, Martelli G, Zhu B, et al. Influence of training on the response of androgen plasma concentrations to exercise in swimmers. *Eur J Appl Physiol Occup Physiol.* 1995;70(2):109-14. <http://dx.doi.org/10.1007/BF00361537>. PMID:7768232.
31. Ahmad G, Moinard N, Esquerre-Lamare C, Mieusset R, Bujan L. Mild induced testicular and epididymal hyperthermia alters sperm chromatin integrity in men. *Fertil Steril.* 2012;97(3):546-53. <http://dx.doi.org/10.1016/j.fertnstert.2011.12.025>. PMID:22265039.
32. Mendiola J, Torres-Cantero A, Agarwal A. Lifestyle factors and male infertility: an evidence-based review. *Arch Med Sci.* 2009;5(1A):S3-12.
33. Mackinnon LT, Hooper SL, Jones S, Gordon RD, Bachmann AW. Hormonal, immunological, and hematological responses to intensified training in elite swimmers. *Med Sci Sports Exerc.* 1997;29(12):1637-45. <http://dx.doi.org/10.1097/00005768-199712000-00014>. PMID:9432098.
34. Mingoti GZ, Pereira RN, Monteiro CMR. Fertility of male adult rats submitted to forced swimming stress. *Braz J Med Biol Res.* 2003;36(5):677-81. <http://dx.doi.org/10.1590/S0100-879X2003000500016>. PMID:12715088.
35. Jørgensen N, Joensen UN, Jensen TK, Jensen MB, Almstrup K, Olesen IA, et al. Human semen quality in the new millennium: a prospective cross-sectional population-based study of 4867 men. *BMJ Open.* 2012;2(4):e000990. <http://dx.doi.org/10.1136/bmjopen-2012-000990>. PMID:22761286.
36. Zou Z, Hu H, Song M, Shen Y, Guo X, McElreavey K, et al. Semen quality analysis of military personnel from six geographical areas of the People's Republic of China. *Fertil Steril.* 2011;95(6):2018-23, 2023.e1-3. <http://dx.doi.org/10.1016/j.fertnstert.2011.02.052>. PMID:21444069.
37. Magnusdottir EV, Thorsteinsson T, Thorsteinsdottir S, Heimisdottir M, Olafsdottir K. Persistent organochlorines, sedentary occupation, obesity and human male subfertility. *Hum Reprod.* 2005;20(1):208-15. <http://dx.doi.org/10.1093/humrep/deh569>. PMID:15567884.
38. Józków P, Mędraś M, Lwow F, Zagrodna A, Słowińska-Lisowska M. Associations between physical activity and semen quality in young healthy men. *Fertil Steril.* 2017;107(2):373-8.e2. <http://dx.doi.org/10.1016/j.fertnstert.2016.11.004>. PMID:27919439.
39. Gaskins AJ, Afeiche MC, Hauser R, Williams PL, Gillman MW, Tanrikut C, et al. Paternal physical and sedentary activities in relation to semen quality and reproductive outcomes among couples from a fertility center. *Hum Reprod.* 2014;29(11):2575-82. <http://dx.doi.org/10.1093/humrep/deu212>. PMID:25164027.
40. Hajizadeh Maleki B, Tartibian B. Long-term low-to-intensive cycling training: impact on semen parameters and seminal cytokines. *Clin J Sport Med.* 2015;25(6):535-40. PMID:24977955.
41. Tan RS, Scally MC. Anabolic steroid-induced hypogonadism-towards a unified hypothesis of anabolic steroid action. *Med Hypotheses.* 2009;72(6):723-8. <http://dx.doi.org/10.1016/j.mehy.2008.12.042>. PMID:19231088.
42. Dyrstad SM, Hansen BH, Holme IM, Anderssen SA. Comparison of self-reported versus accelerometer-measured physical activity. *Med Sci Sports Exerc.* 2014;46(1):99-106. <http://dx.doi.org/10.1249/MSS.0b013e3182a0595f>. PMID:23793232.
43. Stokes-Riner A, Thurston SW, Brazil C, Guzik D, Liu F, Overstreet JW, et al. One semen sample or 2? Insights from a study of fertile men. *J Androl.* 2007;28(5):638-43. <http://dx.doi.org/10.2164/jandrol.107.002741>. PMID:17522415.

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ABBREVIATIONS AND SYMBOLS

PA Physical activity

G Group

BMI Body Mass Index

METs Metabolic equivalent

WHO World Health Organization