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Impact of physical activity on semen quality among men from infertile couples

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ABSTRACT

Objective: To determine the implication of general physical activity and some specific sports in semen quality in men from infertile couples.
Study design: This is an observational study performed in men from infertile couples (n = 454). The interventions performed involved analyzing semen quality parameters according to 2010 WHO criteria and assessing physical activity by means of an International Physical Activity Questionnaire.
Result(s): There was no association between different levels of general physical activity and semen parameters. We neither found association with running, cycling and racquet sports. Interestingly, people who practice weightlifting more than two hours per week presented significantly lower sperm concentration (linear coefficient = −24.80) and lower total sperm count (linear coefficient = −70.87) in comparison with participants that did not practice regular exercise.
Conclusion(s): From a reproductive point of view, there does not seem to be any reason to recommend the increase or the decrease in general physical activity in males from infertile couples. However, additional studies are needed to investigate the relationship between weightlifting and sperm quality.

Introduction

There is a widely-held belief that associates physical activity (PA) with health or being healthy [1]. This idea is supported in part by the World Health Organization (WHO), which generally recommends 150 min per week of moderate to vigorous PA in order to reduce the risk of different diseases [2]. However, a recent review of the current evidence reported that marked health benefits could be obtained with less than half of the level of PA marked by WHO and refused the idea that "more is better" [3]. In agreement with this statement, it has been proposed that, regarding human reproduction, an excess of PA can be harmful for both women [4,5] and men [6–8].

In the last years, an increase in the prevalence of male infertility has been reported [9,10]. A possible though controversial cause of this increase could be the decline observed in sperm count during the past 50 years [11]. Different factors have been described that may be related to the decrease in semen quality, among them, the decrease or the increase of PA [12,13]. In a recent review [14], we found that the impact of PA on semen quality is not the same in athletes or in the general population. While athletes perform very intensive amounts of PA, which could be deleterious, the general population performs recreational PA.

On the other hand, whereas PA has been recommended to prevent or even treat a number of pathological conditions [2], there are no specific recommendations concerning male infertility. In fact, the literature regarding the effect of PA on males from infertile couples is limited, with only three studies including more than 400 participants [15–22].

Therefore, the aim of this study was to further analyze the association between PA and seminal quality in an infertile population. Since there may be a remarkable variation in the daily PA

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resulting from daily non recreational PA, the evaluation of PA has been made by a standardized universally accepted questionnaire, International Physical Activity Questionnaire (IPAQ) [23], which gives a more accurate information of PA [24]. In addition, we studied four different sports (cycling, weightlifting, racquet sports and running), which were assessed by an additional questionnaire.

Materials and methods

Participants

The population under study consisted of 454 men from couples who were actively searching pregnancy and who consecutively attended the Human Reproduction Unit of Cruces University Hospital (Basque Country, Spain) from September 2016 to April 2017. As the participants attended to the infertility unit, they were asked to voluntarily fulfill a physical activity questionnaire the day of semen sample collection. Ethical approval was obtained from the Cruces University Hospital Ethics Committee (CEIC EI7/51) and all of the participants gave written consent regarding their participation.

The main inclusion criteria in this study was that the participant had to be the male partner form infertile couple. The cause of infertility could be either the man, the woman, both or unknown. The male factor (alone or combined with female factor) was defined as an abnormal sperm following WHO criteria [25].

Other inclusion criteria were: 1) infertility >1 year 1) age ≥18 years; 2) absence of the following male conditions: heart disease, diabetes and other endocrine pathologies (hypogonadism), infectious diseases (HIV, syphilis, hepatitis B virus, and hepatitis C virus), prostatitis, varicocele, oncological conditions, neurological and psychiatric conditions; 3) absence of drug treatments that could impair sperm quality; 4) no previous genital surgery.

Medical records were revised to obtain the following data: age, medical and surgical history, smoking, body mass index (BMI). None of them presented a recorded history of anabolic drug consumption.

Semen collection and analysis

Participants were asked to abstain from ejaculation 3–5 days. Semen samples were collected by masturbation either at home or at the hospital. The evaluation of the sample was performed 30–60 min after collection. Semen samples were analyzed according to the 2010 World Health Organization (WHO) criterion [25]. Volume (ml) was estimated using a syringe. Sperm concentration ($x10^6$ sperm/ml) and sperm motility (progressive, non-progressive and immotile (%)) were determined using a Makler® counting chamber (Sefi Medical Instruments, Haifa, Israel) in a heated microscope stage. Volume was multiplied by sperm concentration to obtain total sperm count ($x10^6$ sperm). Finally, haematoxylin-eosin staining was carried out to evaluate sperm morphology.

Physical activity assessment

Participants were asked to complete the short version of the IPAQ on the day the semen sample was collected. This questionnaire, collects information related to the frequency (days per week) and duration (minutes per week) spent in the previous week engaged in vigorous PA, moderate PA, or walking activities [23]. The metabolic equivalents (METs) were used in order to estimate the intensity of the physical activities performed by participants. Results from the IPAQ short version were measured in METs-min/week. Using the compendium of Ainsworth et al. [26], it was possible to calculate the average METs for each level of physical activity (Walking = 3.3 METs, Moderate PA = 4 METs and Vigorous PA = 8 METs). Then, total PA (METs-min/week) was calculated adding walking, moderate, and vigorous PA scores. According to these scores, participants were divided into three groups depending on the intensity of PA as described in the IPAQ [23]. We separated the third group into high and very high subgroups. Consequently, we considered four PA groups: Low (<599 MET-min/week), moderate (600–2999 MET-min/week), high (3000–5999 MET-min/week) and very high (>6000 MET-min/week). In addition, participants were asked to report which type of sports (running, cycling, weightlifting and racquet sports) they had performed in the previous week (hours/week) and were divided into three groups according to intensity (0 h/week, ≤2 h/week and >2 h/week). IPAQ also can measure sedentary behavior in minutes/week.

Data analysis

Semen parameters did not present large deviations from normal distribution according to Kolmogorov Smirnov test, Kurtosis and Kkewness coefficients, therefore they were considered as normal. ANOVA was performed to study the possible differences in semen parameters among PA groups. “Low” and “0 h/week” groups were established as reference for the assessment of the intensity of physical activity and specific sports, respectively.

Table 1
Demographic characteristics of participants separated by levels of intensity of physical activity.

	Activity (METs-min/week)				
	Low (0-599)	Moderate (600-2999)	High (3000-5999)	Very high (> 6000)	p-values
N	83	169	107	95	
Characteristics					
Age (years)	38.24 ± 5.14	37.88 ± 4.30	37.55 ± 3.91	37.04 ± 4.95	0.31[a]
Body Mass Index (BMI)	26.43 ± 3.44	25.68 ± 3.28	25.52 ± 3.23	25.34 ± 3.76	0.17[a]
Current smoker (%)	38.6	30.3	22.6	42.1	0.02[b]
Seminal parameters					
Volume (ml)	3.56 ± 1.57	3.66 ± 1.58	3.47 ± 1.51	3.39 ± 1.53	0.56[c]
Concentration (10^6/ml)	65.10 ± 43.70	59.49 ± 42.10	67.08 ± 49.27	61.90 ± 49.63	0.63[c]
Total sperm count (10^6)	218.50 ± 166.77	204.58 ± 169.16	232.50 ± 206.77	207.32 ± 197.47	0.71[c]
Progressive motility (%)	25.07 ± 10.42	23.57 ± 10.69	24.23 ± 10.97	24.27 ± 12.05	0.87[c]
Total motility (%)	50.54 ± 18.81	47.16 ± 19.98	48.31 ± 21.21	48.11 ± 22.38	0.79[c]
Morphology (%)	2.52 ± 2.24	2.40 ± 1.96	2.37 ± 1.98	2.45 ± 2.11	0.97[c]

[a] ANOVA p-values.
[b] Chi square p-value.
[c] ANOVA p-values adjusted by age, BMI and smoking status. The values for age, BMI and semen parameters are given as Mean ± SD.

Differences between quartiles of sedentary behavior were analyzed. Differences were quantified using linear regression models. All of the analyses were adjusted by known or potential confounders: age, BMI and smoking status. All tests were two-tailed and the level of statistical significance was established at 0.05. Analyses were performed using "R" (version 3.3.1.) [27].

Results

The age of the 454 participants was 37.69 ± 4.52 years (mean ± SD), their BMI was 25.71 ± 3.41Kg/m^2 (mean ± SD) and a 32.6% of them were current smokers. Their level of PA was 4500.12 ± 5763.56 METs-min/week (mean ± SD). The mean values observed for semen parameters (mean ± SD) were the following: Volume 3.54 ± 1.55 ml, concentration 62.81 ± 45.73 × 10^6 sperm/ml, total sperm count 214.28 ± 184.04 × 10^6 sperm, progressive motility 24.15 ± 10.98%, total motility 48.25 ± 20.56% and normal morphology 2.42 ± 2.05%. Male factor was present in 72.5% of the cases. 92% of patients obtained the sperm sample at home, and the sample was analyzed in less than 1 h. The remaining 8% obtained the sample at the hospital. The results were not correlated according the place of sample collection (home or hospital), although there were few cases of hospital collection.

Regarding general PA, the participants who performed moderate intensity PA represented the main group (37.2%), followed by the group of high PA (23.6%), very high PA (20.9%) and low PA (18.3%). The characteristics of the participants included in each of the PA groups are presented in Table 1. No association between the different levels of physical activity and semen parameters was observed in either the ANOVA analysis (Table 1) or linear regression models.

When we examined the association between specific sports and semen parameters, we found that people in the highest intensity group of weightlifting (>2 h/week) had 39.47% lower sperm concentration (10^6/ml) (p = 0.019) and 32.55% lower total sperm count (10^6) (p = 0.123) than the reference group (Table 2). Specifically, linear regression analysis showed significant differences for sperm concentration (linear coef. −24.80 (95% CI = −43.25, −6.34)) and total sperm count (linear coef.−70.87 (95% CI = −138.75,−2.99)) between these two groups. We also noticed that people in the group that performed more than 2 h/week of weightlifting had 21.26% lower progressive motility (%) and 20.76% lower total motility (%) than the reference group, although these differences did not reach statistical significance.

Considering the rest of sports (running, cycling and racquet sports), we did not find any significant associations with semen parameters when ANOVA (Table 3) and linear regression models were fitted. Regarding cycling, we noticed a decrease in the values of semen parameters as the hours per week of cycling increased, although this tendency did not reach statistical significance (Table 3).

The sedentary hours were not correlate either with sperm concentration or with the other sperm parameters analyzed. The results were not correlated according the place of sample collection (home or hospital), although there were few cases of hospital collection.

Discussion

A certain amount of PA is usually recommended to prevent or even to treat a number of medical conditions [2]. On the other hand, a PA over a specific threshold could probably have a negative impact on health [28,29]. However, data regarding PA and sperm quality are controversial. In athletes, a detrimental effect of PA on sperm quality has been shown [7,8]. Nevertheless, data concerning recreational activity in the general population and in infertile

Table 2
Association between weightlifting and seminal parameters.

	Seminal parameters											
	Volume (ml)		Concentration (10^6/ml)		Total sperm count (10^6)		Progressive motility (%)		Total motility (%)		Morphology (%)	
	Mean ± SD	*Linear regression*[a]	*Mean ± SD*	*Linear regression*[a]	*Mean ± SD*	*Linear regression*[a]	*Mean ± SD*	*Linear regression*[a]	*Mean ± SD*	*Linear regression*[a]	*Mean ± SD*	*Linear regression*[a]
Weightlifting (N = 150)												
0 h/wk (n = 83)	3.55 ± 1.58	Ref.	65.22 ± 43.75	Ref.	217.64 ± 166.82	Ref.	25.07 ± 10.42	Ref.	50.48 ± 18.82	Ref.	2.52 ± 2.24	Ref.
≤ 2 h/wk (n = 33)	3.31 ± 1.36	−0.20 (−0.85,0.45)	65.38 ± 48.97	−3.05 (−21.46,15.37)	194.89 ± 151.34	−32.13 (−99.86,35.60)	23.94 ± 11.88	0.25 (−4.42,4.92)	46.82 ± 21.99	−1.04 (−9.66,7.57)	2.52 ± 2.11	0.12 (−0.71,0.96)
>2 h/wk (n = 34)	3.63 ± 1.46	0.10 (−0.55,0.75)	39.48 ± 36.20	−24.80 (−43.25,−6.34)	146.79 ± 133.73	−70.87 (−138.75,−2.99)	19.74 ± 11.94	−3.56 (−8.24,1.12)	40.00 ± 23.20	−6.97 (−15.60,1.67)	1.56 ± 1.58	−0.52 (−1.35,0.32)
ANOVA[b]	0.67		0.02		0.12		0.09		0.08		0.07	

[a] Coefficients of linear regression with 95% CI.
[b] ANOVA p-values. All models have been adjusted by age, BMI and smoking status.

Table 3
Association between running, cycling, and racquet sports and seminal parameters.

	Seminal parameters					
	Volume (ml)	Concentration (10^6/ml)	Total sperm count (10^6)	Progressive motility (%)	Total motility (%)	Morphology (%)
Sports						
Running (N = 174)						
0 h/wk (n = 93)	3.57 ± 1.54	66.79 ± 43.99	223.04 ± 161.90	25.50 ± 10.02	51.78 ± 18.11	2.54 ± 2.23
≤2 h/wk (n = 51)	3.71 ± 1.46	58.27 ± 45.16	206.05 ± 152.12	22.94 ± 10.37	46.45 ± 19.14	2.12 ± 1.85
>2 h/wk (n = 30)	2.96 ± 1.20	66.0 ± 47.55	178.69 ± 131.36	23.67 ± 12.32	45.83 ± 22.82	2.17 ± 1.90
ANOVA[a]	0.09	0.24	0.29	0.36	0.17	0.45
Cycling (N = 154)						
0 h/wk (n = 83)	3.61 ± 1.58	64.00 ± 44.048	216.29 ± 168.05	25.19 ± 10.42	50.78 ± 18.67	2.52 ± 2.24
≤2 h/wk (n = 38)	3.95 ± 1.50	65.08 ± 46.64	226.46 ± 160.68	25.5 ± 9.0	51.08 ± 17.21	2.34 ± 1.96
>2 h/wk (n = 33)	3.2 ± 1.47	57.39 ± 47.83	181.21 ± 174.076	20.88 ± 12.36	42.30 ± 23.25	2.30 ± 2.21
ANOVA[a]	0.19	0.87	0.66	0.16	0.13	0.93
Tennis / Padel (N = 107)						
0 h/wk (n = 82)	3.55 ± 1.57	65.87 ± 43.40	221.05 ± 166.16	25.07 ± 10.48	50.61 ± 18.92	2.54 ± 2.25
≤2 h/wk (n = 16)	3.025 ± 1.42	67.13 ± 50.90	182.87 ± 120.0	22.75 ± 12.16	44.5 ± 22.74	2.94 ± 2.64
>2 h/wk (n = 9)	3.76 ± 1.55	83.0 ± 28.97	295.62 ± 143.52	24.44 ± 11.58	53.33 ± 21.21	3.56 ± 1.94
ANOVA[a]	0.19	0.73	0.31	0.78	0.34	0.47

[a] ANOVA p-values adjusted by age, Body Mass Index (BMI) and smoking status. The values for semen parameters are given as Mean ± SD.

patients are controversial [14]. Regarding infertile patients, there are only 8 studies published up to date [15–22]. A number of the discrepancies in results between the studies may be related to different factors: 1) Sample size (only 3 studies with > 400 patients [16, 18, 21]). 2) Method for PA assessment (observational studies [17,19,16–22] or interventionist studies [15,16,18],); 3) The PA established cut-offs (quartiles [19], tertiles [17]); 4) The intrinsic population characteristics (American [19,21], European [17,20,22] and Asian [15,16,18]). Considering these factors, in our study, we have measured PA using the IPAQ [23], which presents the advantage of considering the total PA performed by the individual, including recreational activity and also work-related and transport-related PA. In addition, it has well established cut off points for PA and our study was performed with large sample size and statistical power.

Our results did not show any association between PA and the studied semen parameters, being all the values very similar among the four groups of PA (Table 1). In agreement with our results, none of the other studies performed on infertile patients have found association between PA and neither volume [15–22] nor total motility [17,20,21]. Regarding sperm concentration, in agreement with our results, other two studies have not found any association [21,22]. In this line, another study also did not find association when they examined PA in terms of METs, significant differences being only observed when they measured PA by quartiles of hours/week [19]. Likewise, Parn et al. [17] found an inverted U-shape association, suggesting that men in the middle tertile of moderate to vigorous PA had better sperm concentration than those in the first or third tertile. This is the only one of these studies where the PA was objectively measured using accelerometers, however, sample size is relatively reduced (n = 57). In addition, the three interventionist studies found significant differences in the concentration [15,16,18]. Nevertheless, their studies did not consider METs and population criteria excluded smoking and alcohol consumption. Indeed, overweight was frequent, and PA was associated with a decrease in body weight, which could be a confounding factor. With respect to total sperm count, progressive motility and morphology, in agreement with our results, none of the observational studies found association with PA [17,19,16–22]. Only the interventionist studies did find an association [15,16,18]. However, these discrepancies could be due to the differences mentioned before. Additionally, we did not find any association either between sedentary behavior and sperm parameters. Although this result is not consistent with the inverse association between television watching and sperm concentration and total sperm count reported by Gaskins et al. [30], it must be noted that the present study is focused on infertile patients while they studied young men, which could be the source of discrepancies.

On the other hand, we have also analyzed the effect of four specific sports on semen quality. Only other two studies have analyzed the effect of running [19,21], cycling [19,21], weightlifting [19,21] and racquet sports [19] on semen quality in an infertile population. In line with our results, these two studies have not found any significant association between running or racquet sports and semen parameters. In relation to cycling, we noticed a decrease in semen parameters associated with increasing hours dedicated to this sport in our study population. Although our results did not reach statistical significance (Table 3), they are consistent with previous observations finding that people in the highest intensity group of cycling had significantly lower sperm concentration [19,21] and normal morphology [21] than the control group.

Surprisingly, when we analyzed weightlifting, we found that the practice of more than two hours per week was associated with a significant decrease in sperm concentration and total sperm count. These results differed from those previously reported by other authors, one of them showing no influence [21] and the other one a small improvement [19]. Therefore, it is difficult to assess the true impact of weightlifting, as there are other confounding factors which could be associated with weightlifting, such as muscularity increase, eating disorders and steroid consumption [31–33] that could affect semen quality. The latter could be discarded since anabolic androgens (AA) consumption was denied in the questionnaire and a remarkable decrease in sperm quality, as expected with the use of AA, was not observed.

There are a few additional limitations to bear in mind in this study. First, it is an observational study and, although known confounders have been considered, it is possible that other factors, such as socio-economic status or androgen consumption may have affected our results. Secondly, the use of the IPAQ self-reported questionnaire for PA assessment could have inherent disadvantages, such as the misunderstanding of some questions or exaggerated answers, which could lead to a misclassification of PA. In addition, it could be argued that more precise results could

be obtained with the use of objective measurements of PA, such accelerometers. However, it should be noted that IPAQ is a widely accepted method for PA quantification, and that a very good correlation with objective measurements has been previously reported [24]. Finally, we have analyzed an only semen sample although the desirability of requesting multiple samples in population studies of semen quality is not clear [34].

In summary, the findings of the present study indicate that there is no association between general PA and semen parameters in men from infertile couples. Therefore, we can conclude that, from a reproductive point of view, there does not seem to be any reason to recommend the increase or the decrease in PA in males from infertile couples. On the other hand, we have found that weightlifting (>2 h/week) is associated with lower sperm concentration and total sperm count. However, additional studies are needed to investigate the relationship between weightlifting and sperm quality.

Author contribution

RM and AGO contributed to the conception and design of the study. JIP, BC, VA, BP and JI acquired the data. JIP and BSZ analyzed the data. JIP, ELL and RM interpreted the results and drafted the article. All authors have read, reviewed critically and approved the final manuscript.

Conflicts of interest

The authors declare no conflicts of interest.

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