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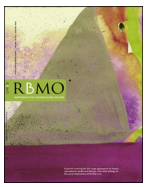

ARTICLE

Gym lifestyle factors and male reproductive health: a study into young adult usage and perceptions

BIOGRAPHY

Meurig T. Gallagher is a truly interdisciplinary researcher. Having been awarded a PhD in Applied Mathematics from the University of Birmingham, UK, he now holds a joint post across Mathematics, Computer Science and the Medical School. His research focuses on integrating approaches to understanding male infertility from diagnostic, therapeutic and societal perspectives.

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KEY MESSAGE

Men have a significant lack of concern over their own fertility and the potential negative effects of gym supplementation. They would consider changing behaviour if they knew about the long-term negative consequences, but feel that male reproductive health is not discussed prominently. This highlights the need for targeted educational interventions.

ABSTRACT

Research question: What level of awareness do young adults have regarding the potential impacts of gym lifestyle factors and supplementation on male infertility?

Design: Between February and March 2023 a questionnaire ($n = 153$) was employed to gauge attitudes to and awareness of the effects of male reproductive health and gym lifestyles on male fertility. Two semi-structured focus groups ($n = 10$ total), stratified by sex assigned at birth, were conducted using a set of discussion topics.

Results: The survey revealed a statistically significant difference between male and female awareness of the potential impacts of some forms of high-intensity exercise and protein supplementation on male reproductive health ($P = 0.045$). Many men do not think about fertility unprompted; the survey revealed that fewer men have thought about their fertility compared with those who are curious about their fertility ($P = 4.7 \times 10^{-5}$) and those who believe their personal fertility is important to them ($P = 8.1 \times 10^{-6}$). Men were more likely to make a change in their behaviour if it had a long-term compared with a short-term effect on their fertility ($P < 10^{-5}$). Five focus group themes surrounding awareness of male reproductive health were extracted.

Conclusions: This work has shown that there is a significant lack of awareness and information surrounding the effects of gym lifestyles on male infertility in a young adult UK population. Crucially, levels of awareness differ significantly between men and women. Men have a potentially alarming lack of concern over their own fertility and how factors such as gym supplements can have negative long-term impacts.

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KEYWORDS

Gym supplements
Lifestyle impacts
Male fertility
Male reproductive health
Qualitative study

INTRODUCTION

According to the most recent estimates by the World Health Organization (*World Health Organization 2023*) infertility affects 1 in 6 people worldwide. Male factor infertility accounts for up to half of these cases, yet male reproductive health (MRH) is neglected by policies and health programmes globally (*Kumar and Singh 2015*). There is a global crisis in MRH due to a lack of research funding, absence of early diagnosis and treatment, and lack of societal awareness and education surrounding men's infertility (*De Jonge and Barratt 2019*). Hence, infertility remains largely viewed as a predominantly female issue, unfairly placing the emotional and physical burden of treatment onto the woman.

In many societies virility, strength and the ability to have a child are seen as important characteristics of masculinity (*Gannon et al., 2004*). The distress of female infertility is well understood, while for males there remains a source of stigma (*Hanna and Gough 2020*). With the evidence showing worldwide trends in decreasing sperm counts (*Levine et al. 2017*; *Levine et al. 2022*), and clear associations between male age and a decrease in fertility (*Horta et al. 2019*), there is a clear need for greater understanding and education surrounding MRH.

The importance of MRH has been emphasized by the strengthening of evidence linking reproductive health to both paternal somatic health and the health of the offspring (*Choy and Eisenberg 2018*). However, insufficient societal awareness and discussions surrounding MRH remain a barrier. The results from a questionnaire investigating male attitudes towards fertility revealed that 73% of men were not very likely to discuss their fertility with others, and 50% of men from northern Europe who took part felt negative or conflicted about their views regarding their fertility (*De Jonge et al., 2023*).

Another study involving interviews with men, women and health professionals reported that both men and women viewed infertility as a female issue (*Grace et al. 2019*), with healthcare professionals expressing that men have low engagement in reproductive health discussions and poor knowledge of MRH. This study suggests that the lack of engagement in infertility is related to the lack of voice men feel they have in discussions that have traditionally focused on women – which becomes a self-fulfilling prophecy. Women are known to make up to 80% of family healthcare decisions, including those for their male partners, further raising the importance of including everyone in the discussions, education and subsequent removal of stigma surrounding MRH (*Miner et al. 2018*).

Evidence points towards a gap in the awareness of male infertility risk factors, with responses from one survey revealing that men could only identify half of the modifiable, and fewer than half of the fixed, risk factors associated with infertility (*Daumler et al., 2016*). This is compounded in younger adults, with other work uncovering that 26- to 30-year-old males disagreed significantly, compared with other age groups, that modifiable lifestyle factors (e.g. smoking, drinking and weight) could have an effect on their fertility (*Stevenson et al., 2021*). This growing body of work illustrates the requirement for an improved education of young adults concerning lifestyles and potential modifiable factors that could aid in tackling preventative infertility, as well as aiding earlier recognition and diagnosis.

Gym use is on the rise in the UK, with research showing the significance of gym culture and contemporary masculinity (*Gibbs et al., 2022*). Evidence suggests that this may, however, come at a cost to fertility, with weightlifting (*Ibañez-Perez et al., 2019*), cycling (*Gaskins et al., 2014*; *Maleki et al., 2014*; *Wise et al., 2011*) and physical strength (*Foo et al., 2018*) having been shown to negatively correlate with sperm quality, although there have been conflicting studies that have shown the opposite trends for both cycling (*Ibañez-Perez et al., 2019*) and weightlifting (*Gaskins et al., 2014*). Meanwhile, there is a significant market for gym supplementation to support this culture, with the market intelligence agency Mintel reporting that, in the UK in 2016, 12% of people and 23% of men aged 16–24 years were taking supplements for exercise (*Mintel, 2016*).

The science regarding the impacts of protein supplementation on MRH is far from settled. A recent pilot study investigating the effects of these supplements on semen parameters found that abstinence from supplementation correlated with a 2.6-fold increase in sperm concentration compared with normal values (*Ketheeswaran et al., 2019*). There are some concerns regarding high concentrations of the female hormone oestrogen, and the plant equivalent phytoestrogens/isoflavones, in whey and soy protein supplements. Studies in mice have shown no significant effect of whey protein after 3 months of consumption (*Ketheeswaran et al., 2020*), whereas in rodents a reduction of serum testosterone concentration and prostate weight has been identified with increased dietary soy phytoestrogen consumption (*Weber et al., 2001*), with a 20% reduction in litter size and a 25% decrease in epididymal sperm count seen in male mice fed a high phytoestrogen diet (*Cederroth et al., 2010*). One human investigation revealed an inverse relationship between soy intake and sperm concentration (*Chavarro et al., 2008*). Contrasting with this information, a subsequent study showed that the semen parameters in healthy adult males were not significantly altered by 2 months' consumption of either a high or low soy isoflavone protein isolate diet (*Beaton et al., 2010*). The conflicted nature of this evidence calls for further studies involving protein supplementation on healthy humans, and motivates the need for a greater awareness of potential effects, particularly in young men who frequently use such supplementation.

This investigation focuses on the lack of awareness surrounding the associations between gym lifestyle factors and MRH, aiming to quantify levels and differences in understanding between men and women in the target population. In particular, the aim was to extract the personal voices of participants to understand their wider thoughts regarding MRH, and more specifically the potential impacts on male fertility. This understanding hopes to provide targets for educational interventions to help share the burden of reproductive health more equitably.

MATERIALS AND METHODS

Study population and ethical approval

Two key methodologies were used for this cross-sectional study: an online questionnaire open to all but targeted at students attending the University of Birmingham, UK; and two focus groups, each comprising five attendees and split by self-identified gender.

Ethical approval for this study was granted by the School of Biomedical Sciences (University of Birmingham) Ethics Board, with code BMS_2023_01 and approval date 27 February 2023.

Questionnaire design and distribution

A questionnaire was designed and distributed to the study population to assess the awareness of both MRH and the associations between gym lifestyles and male infertility. The questionnaire was anonymous and voluntary, and participants could leave the survey at any time for any reason. An introductory page of the questionnaire gave participants all the necessary information about the study. Informed consent was submitted by all participants when they enrolled in the study.

The questionnaire included three sections, through which participants were routed depending on their self-reported sex assigned at birth, where participants could identify as 'male', 'female' or 'other'. The sections comprised: section 1, general information about the participants; section 2a, information on male lifestyles, or 2b, information on female and 'other' lifestyles; and section 3, assessments of awareness of MRH. Sections 2a and 2b differed only by the inclusion of a question on anabolic steroid use for male respondents, selected because of existing evidence showing anabolic steroid use being as low as 0.1% among women (*Kanayama et al., 2007*). Questions regarding the participants' reasoning behind steroid or protein supplementation use only appeared if the respondents reported a use of these. Assessment of awareness surrounding the effects of gym lifestyle factors was captured on a 5-point Likert scale (*Likert, 1932*), with the specific MRH questions asked only to men. The full list of the questions can be found in Appendix A.

The questionnaire was constructed using the JISC Online Surveys platform and open for submissions between the 28th February and 12th March 2023. Access to the survey was not restricted, but the study population (young adults of reproductive age) was targeted explicitly. The predominant method used to share the questionnaire was student (particularly University of Birmingham) focused. In addition, posters with a QR-code link to the survey were displayed around the University of Birmingham campus. The JISC platform does not provide the capability to prevent participants submitting more than one response, or to measure unsubmitted/partial responses. However, the survey completion times were checked for possible duplicate entries.

Questionnaire data analysis

Quantitative analysis in Python Software Foundation, USA was performed on the questionnaire responses to assess the differences between groups. To minimize the number of statistical comparisons, the male questionnaire responses were grouped into three categories: A, awareness of personal fertility; B, awareness of gym use and fertility; and C, understanding of the specific effects on fertility. Pairwise Wilcoxon rank tests (*Hollander et al., 2013*) with Bonferroni correction (*Shaffer, 1995*) across each group were conducted in R (*R Core Team, 2023*). Pairwise comparisons between the answers of men and women in the awareness of MRH factors were assessed similarly. All tests were considered significant with a P-value <0.05.

Questionnaire reporting followed the Checklist for Reporting of Survey Studies (CROSS) (*Sharma et al., 2021*) and the Standards for Reporting Qualitative Research (SRQR) (*O'Brien et al., 2014*).

Focus group design

Focus group participants were recruited through student groups at the University of Birmingham. The focus group participants were not asked if they had also undertaken the questionnaire, thereby maintaining the anonymity of the previous responses. Two groups were formed based on the sex assigned at birth, with male ($n = 5$) and female ($n = 5$) focus groups taking place on consecutive days to ensure continuity of the methods used. A single focus group design (*Nyumba et al., 2018*) was employed, stratified by gender in this way owing to the need to ensure a comfortable environment for discussing what is seen by some to be a taboo topic. All the participants were given a comprehensive introduction to the project and provided informed consent, including consent for audio-recordings of the discussions to be made.

The focus groups were semi-structured to ensure that each group discussed all topics, while providing space for active discussion between the participants. A discussion topic list was used, developed by the authors' desire for information surrounding key topics. The full discussion topic list can be found in Appendix B.

Focus group data analysis

The focus group audio was audio-recorded and transcribed, before being kept on a secure server and the audio files being deleted. A thematic analysis was conducted (*Braun and Clarke 2019*), with transcripts coded by A.N.-S. according to codes relating to either healthcare communication or reproductive health. The codes were discussed with M.T.G. to minimize personal bias, from which themes were generated iteratively through discussion between all authors.

RESULTS

Questionnaire results

Demographics

The questionnaire was answered by a total of 153 respondents, with 46% responding as male, 54% as female, and none as other (FIGURE 1a). Of these, the vast majority (all but eight individuals) were in the 18–25 years age range, with two men in each of the <18, 26–32 and 33–40 years age brackets, and the remaining two women being in the 26–32 years age bracket (FIGURE 1b).

The survey population was very active, with distributions of the number of hours of exercise undertaken per week centred upon 3–5 h (female) and 6–9 h (male) (FIGURE 1c), conducted both in the gym and elsewhere (FIGURE 1d).

Regarding gym supplementation, the majority of both men (79%) and women (56%) reported using or having used protein supplements (FIGURE 1e), with just one man reporting having used anabolic steroids (FIGURE 1f), with a reported purpose of improving muscle gain. The reasoning for supplementation varied (TABLE 1): 95% of men used protein supplements for the purpose of gaining muscle, compared with just 65% of women; similar proportions of men and women use supplementation for additional nutrition (41% and 37%) and injury recovery (16% and 11%); however, 26% of women used protein supplements for weight loss, while no men reported doing the same; six participants had 'other' reasons for supplementation.

Awareness surrounding the associations between both exercise and protein supplements and MRH is lower in men than women

The results of the questions assessing awareness of the associations between gym lifestyle factors and MRH are shown in FIGURE 2, split according to sex assigned at birth. The survey revealed no statistically significant differences in the respondents' awareness surrounding the potential negative impact of anabolic steroid supplements on MRH (the

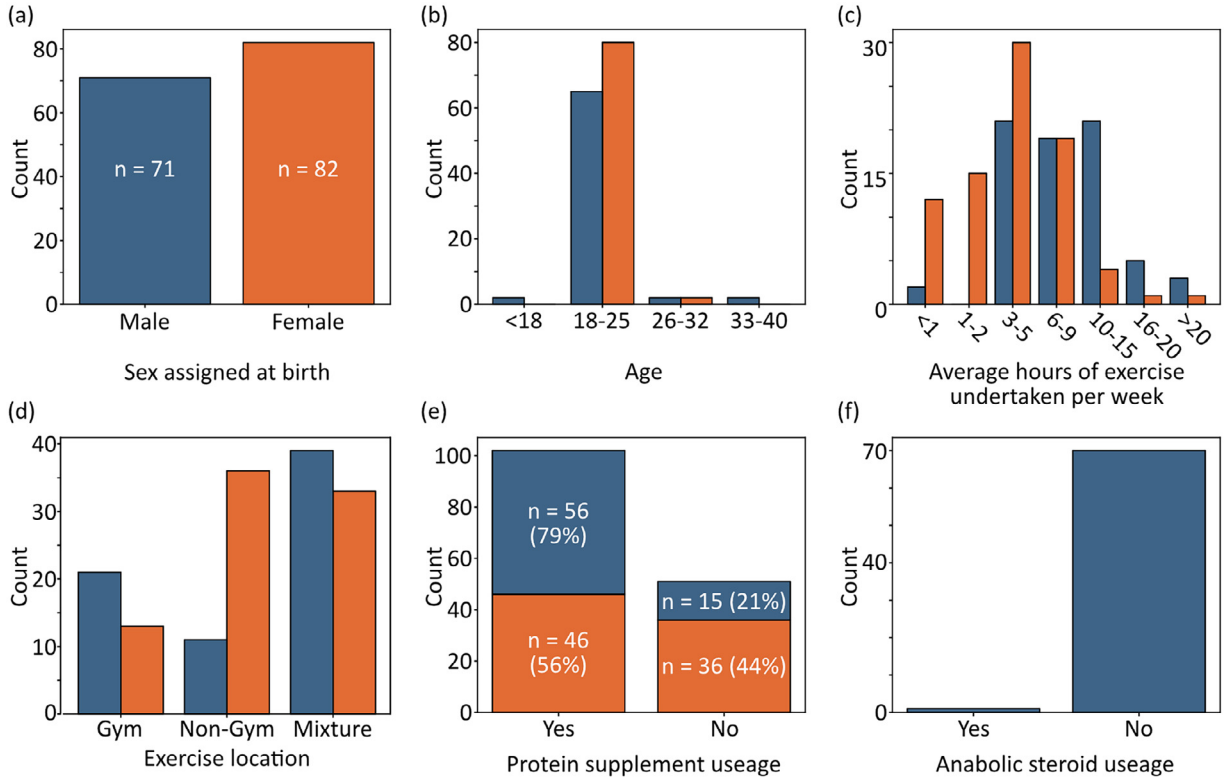

FIGURE 1 Demographics of survey responders. In each panel the colours correspond to the sex assigned at birth of the respondents as per panel (a) (blue, male; orange, female). In panel (e), the percentages show protein supplement usage stratified by sex assigned at birth.

majority being aware), or that some protein powders have been found to be contaminated with anabolic steroids (the majority being unaware). Interestingly, however, there were statistically significant differences between the awareness of the potential negative effects of some forms of high-intensity exercise on male infertility ($P = 0.045$), and of protein supplementation on sperm quality ($P = 0.047$); for each question women reported greater awareness than men.

Fertility is important to men, but many do not think about it unprompted

Men's attitudes towards their fertility are shown in FIGURE 3, A1. A total of 52% of men (strongly) agreed with the statement 'I have thought about my fertility before', whereas only 34% of men (strongly) disagreed (FIGURE 3, A1). There is a statistically significant difference in the attitudes of men thinking about their fertility compared with both those curious about their fertility ($P < 0.0001$, FIGURE 3, A2), and those who believe their personal fertility is important to them ($P < 10^{-5}$, FIGURE 3, A3). The vast majority agreed or strongly agreed with these latter two statements (79% and 82%, respectively). The results from all the comparisons are shown in TABLE 2 (group A).

TABLE 1 REASONING GIVEN BY RESPONDENTS FOR THE USE OF PROTEIN SUPPLEMENTATION

Reason for supplementation	Percentage of total responses	
	Male	Female
Muscle gain	95	65
Additional nutrition	41	37
Injury recovery	16	11
Weight loss	0	26
Other[a]	4	9

$n = 102$ (56 male, 46 female). The table shows the percentage of respondents of each sex selecting each answer (where multiple answers could be selected). Responses are presented from the most to the least selected.

[a] Responses specified were for weight gain ($n = 3$), recovery from training sessions ($n = 1$), keeping protein levels up as a vegetarian ($n = 1$) and heathier alternatives to, for example, regular chocolate bars ($n = 1$).

Men have not considered the impact of gym routines and supplements on their fertility, but would change their behaviour

Just 14% of the men surveyed have thought about the consequences of gym routines and supplementation on their fertility (FIGURE 3, B1). There was a statistically significant difference between whether men had thought about these consequences and whether they thought the benefits of gym routines and supplementation were more important to them than their fertility ($P < 0.001$; FIGURE 3, B2), with 38% (strongly) disagreeing and 28% (strongly) agreeing with this statement.

When asked if they would change their behaviour if they knew it had a long-term impact on their fertility (FIGURE 3, B3), 76% of men either agreed or strongly agreed. In contrast, significantly fewer ($P < 10^{-5}$) men, just 41%, would change their behaviour if they knew it had a short-term impact

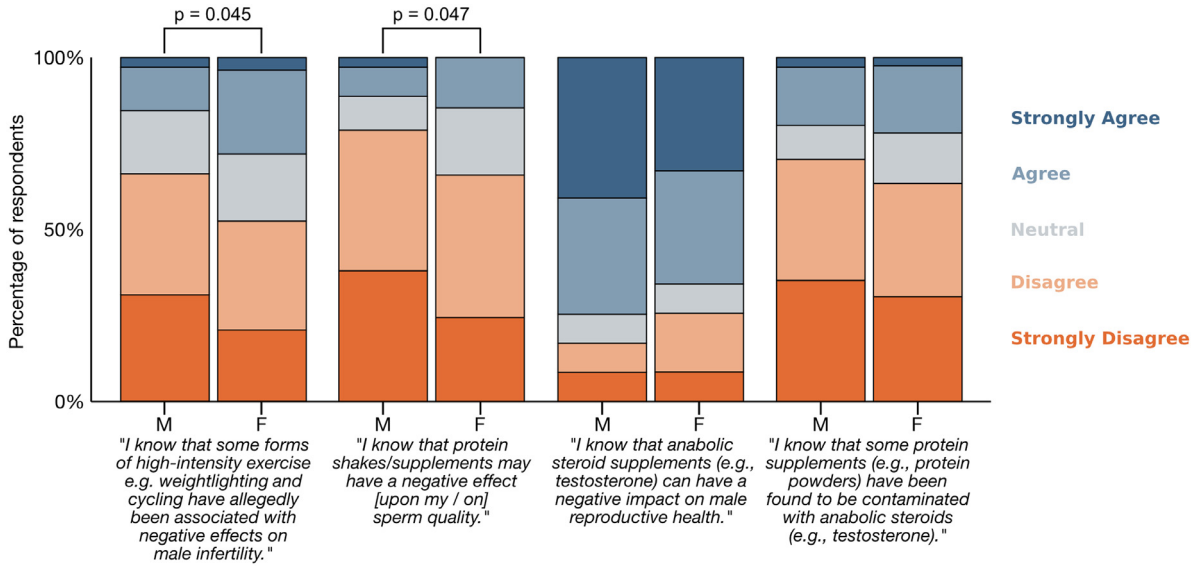

FIGURE 2 Differences between men and women in the level of awareness of factors that affect male fertility, shown as a percentage of respondents in each category on a 5-point Likert scale. Comparisons were made using pairwise Wilcoxon rank tests with Bonferroni correction.

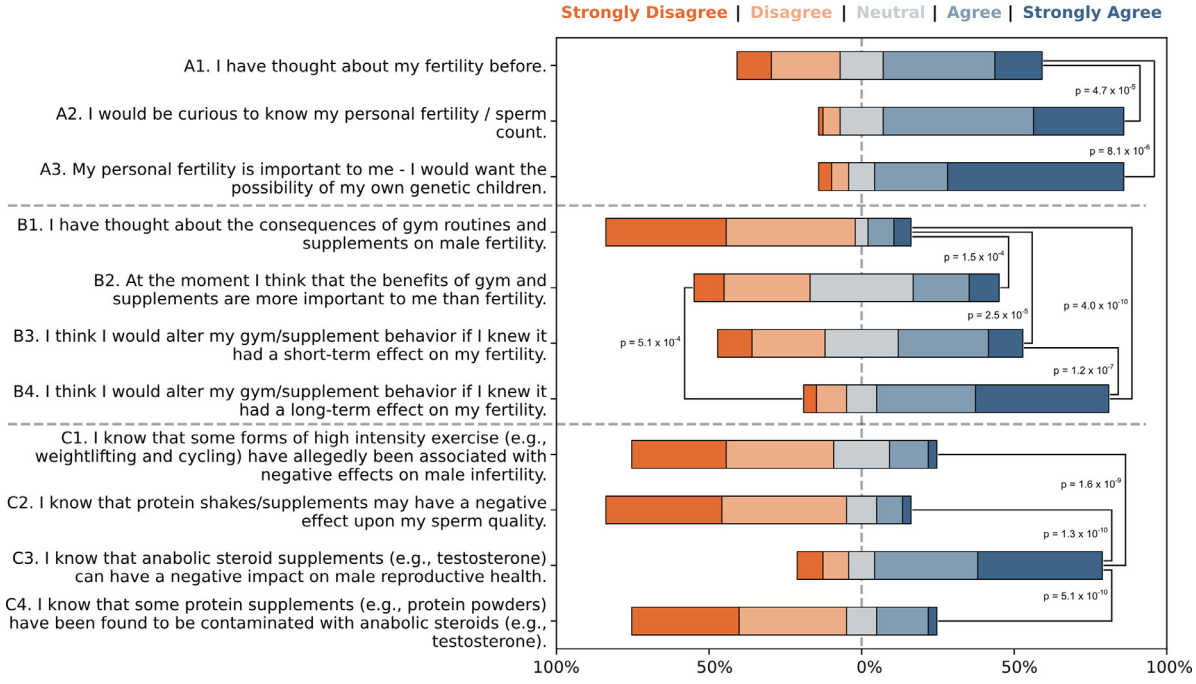

FIGURE 3 Attitudes and understanding of fertility of the male participants in the survey, shown as the percentage of respondents in each category on a 5-point Likert scale. Comparisons were made using pairwise Wilcoxon rank tests with Bonferroni correction. Further results are shown in TABLE 2.

(FIGURE 3, B4). The results from all THE comparisons are shown in TABLE 2 (group B).

Knowledge of the effects of anabolic steroids on fertility was far greater than for other factors

The majority of respondents were aware that anabolic steroids can have an impact on MRH (75% agreed or strongly agreed; FIGURE 3, C3). This is statistically significantly different from the awareness of the impacts of some forms of high-intensity exercise (15% agreed or strongly agreed, $P < 10^{-5}$; FIGURE 3, C1), protein supplementation (11% agreed or strongly agreed, $P < 10^{-5}$; FIGURE 3, C2) or protein supplement contamination (13% agreed or strongly agreed, $P < 10^{-5}$; FIGURE 3, C4). The results from all the comparisons are shown in TABLE 2 (group C).

Survey participants

Two focus groups were conducted each with five participants aged 18–25 years, split by the sex assigned at birth. All the participants were students at the University of Birmingham, UK, and therefore had, or were working towards, a degree-level education. Most participants were heterosexual (80%), with two homosexual males taking part.

TABLE 2 RESULTS FROM PAIRWISE WILCOXON RANK TESTS WITH BONFERRONI CORRECTION BETWEEN THE ATTITUDES AND UNDERSTANDING OF FERTILITY OF THE SURVEY'S MALE PARTICIPANTS (AS SHOWN IN FIGURE 3)

Group A: Awareness of personal fertility

Statement[a]	A1 (*P*-value)	A2 (*P*-value)	A3 (*P*-value)
A1	–	–	–
A2	4.7×10^{-5}	–	–
A3	8.1×10^{-6}	0.31	–

Group B: Awareness of gym use and fertility

Statement[b]	B1 (*P*-value)	B2 (*P*-value)	B3 (*P*-value)	B4 (*P*-value)
B1	–	–	–	–
B2	1.5×10^{-4}	–	–	–
B3	2.5×10^{-5}	1.0	–	–
B4	4.0×10^{-10}	5.1×10^{-4}	1.2×10^{-7}	–

Group C: Understanding of specific effects on fertility

Statement[c]	C1 (*P*-value)	C2 (*P*-value)	C3 (*P*-value)	C4 (*P*-value)
C1	–	–	–	–
C2	0.18	–	–	–
C3	1.6×10^{-9}	1.3×10^{-10}	–	–
C4	1.0	1.0	5.1×10^{-10}	–

[a] A1: I have thought about my fertility before; A2: I would be curious to know my personal fertility/sperm count; A3: My personal fertility is important to me – I would want the possibility of my own genetic children.

[b] B1: I have thought about the consequences of gym routines and supplements on male fertility; B2: At the moment I think that the benefits of gym and supplements are more important to me than fertility; B3: I think I would alter my gym/supplement behaviour if I knew it had a short-term effect on my fertility; B4: I think I would alter my gym/supplement behaviour if I knew it had a long-term effect on my fertility.

[c] C1: I know that some forms of high-intensity exercise (e.g. weightlifting and cycling) have allegedly been associated with negative effects on male infertility; C2: I know that protein shakes/supplements may have a negative effect upon my sperm quality; C3: I know that anabolic steroid supplements (e.g. testosterone) can have a negative impact on male reproductive health; C4: I know that some protein supplements (e.g. protein powders) have been found to be contaminated with anabolic steroids (e.g. testosterone).

Survey themes

To understand the points of view of those in the focus groups, a set of codes were extracted from which five themes were identified:

1. The use of the internet, family and friends (particularly women), for healthcare information.
2. Female dominance in reproductive health.
3. Need for engaging, trustworthy and accessible social media healthcare information.
4. Lack of consideration, and subsequent lack of discussion, surrounding MRH.
5. Increased information seeking and MRH discussion as age increases.

The codes from which these themes were extracted are shown in FIGURE 4, which were grouped into those corresponding to healthcare communication (leading to themes 1 and 3), and those regarding reproductive health (themes 2, 4 and 5). Respondents were coded F1–F5 and M1–M5 for the female and male focus groups, respectively.

Theme 1: The use of the internet, family and friends (particularly women) for healthcare information

Of the 10 focus group participants, none had ever previously sought information on male fertility or MRH. Most participants, both men and women, expressed that when looking for healthcare information 'the internet is the first thing I use' (F5), with most also using the UK National Health Service website or 'any source [they] recognise that seems like a medical institute' (F1). This research would open be followed by 'asking friends or other people' (F1) or 'talking to friends and family who might have experience' (F5). There was a particular focus on female figures in this stage of the healthcare information-seeking process, with male participants stating that 'I get most of my information from my girlfriend' (M1) and 'I'd probably talk to my mum about it' (M3).

Theme 2: Female dominance in reproductive health

Much of the discussion centred around the fact that female fertility is far more prominent a topic than male fertility or MRH. Participants emphasized that 'it's a lot of discussion [about female fertility] but it's never about the male side of it' (M2), and that 'I feel like there are sometimes conversations about reproductive health, but I don't think we have ever had a conversation about male reproductive health' (M1).

Indeed, one female focus group member stated that their first thought when considering fertility was of 'a heterosexual woman' (F1), with another remarking 'female infertility is heavily focused on compared to males. I've heard and learnt more about female infertility compared to males' (F3).

The stress on inequality in reproductive health education was evident, with M4 stating, 'I don't even know the influences on [MRH], like I don't know how to maintain good reproductive health – be healthy?'

Many misconceptions in participants' understanding about reproductive health revealed this inequality indirectly, such as 'women have a time limit compared to men' (F2), 'there's more possible issues with women than there are with men' (F2) and 'because I'm the one getting pregnant . . . it is female fertility that is the biggest thing' (F1).

Participants felt that female dominance in conversations around reproductive health occurs due to conversations involving 'endometriosis or PCOS [polycystic ovarian syndrome]' (M2) and 'the pill, whereas [with] male infertility there's no pathway to bring up the conversation' (F2). Men felt that 'we don't have to think about it ever, whereas if you're a girl you have to . . . every month' (M1), with women also raising periods as an indicator of fertility – 'if you have a regular period, it's a clear indication' (F4), with acknowledgement that 'males aren't going to know where they're infertile or not unless they get tested' (F3). It was also pointed out that women are regularly asked in clinical conversations whether they have a regular

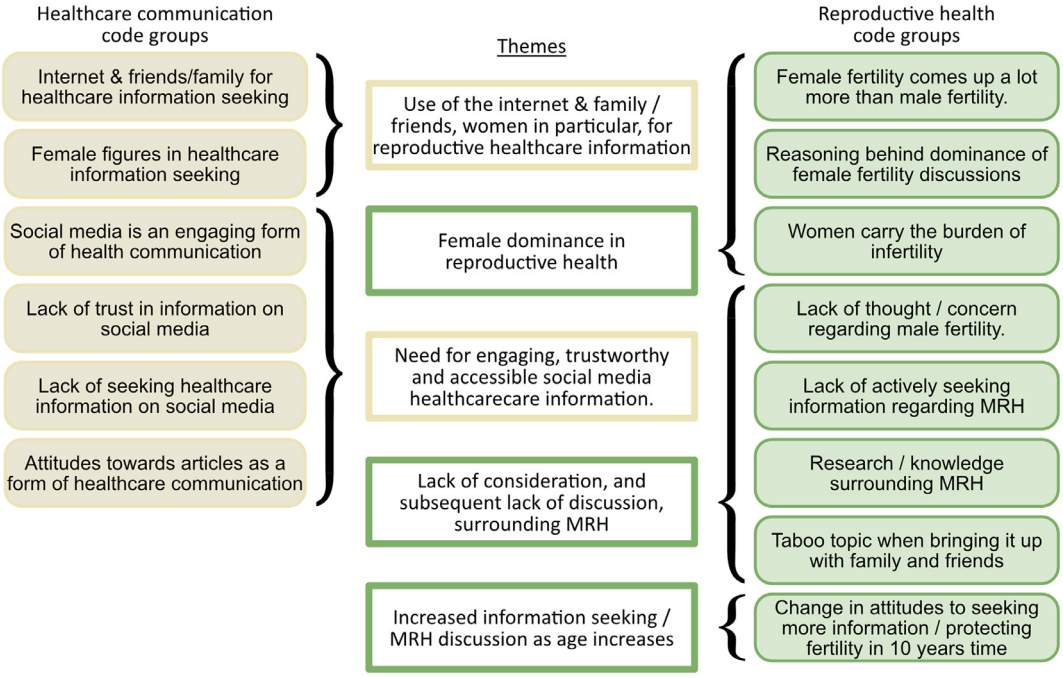

FIGURE 4 Focus group thematic analysis. MRH, male reproductive health.

period, while men have no comparative interactions.

Theme 3: Need for engaging, trustworthy and accessible social media healthcare information

Focus group participants felt that social media channels were an engaging form of healthcare communications, as they are 'effective as in they get information out quickly and hold attention and spread information' (M2). Female participant F1 highlighted that 'a short advert or a short Instagram reel [contains] a lot of information but condensed and is visually engaging'. Despite the engaging nature of social media as a form of healthcare communication, participants had a lack of trust surrounding the accuracy of the information, with individuals not 'trust[ing] stuff on social media as much as a news article' (F4) or not 'know [ing] where they have got the information from or whether they have just pulled it from somewhere and interpreted it wrong to then present it incorrectly to everyone else' (F3). There was, however, a general attitude of low engagement with scientific articles, with it being 'likely that I wouldn't read all of it' (M1).

Theme 4: Lack of consideration, and subsequent lack of discussion, surrounding MRH

It was clear among both the male and female focus groups that they had 'never really thought about [MRH]' (M3), since 'we've never had a need to, like none of us are trying to get pregnant' (F3). There was also a shared lack of actively seeking information on MRH, with one male participant commenting 'It's never something [I'm] curious about that [I] would go and research it like I would some other things' (M2), with many others agreeing. In contrast, M4 highlighted that 'the only thing [I've] researched in fertility is [cycling], I once heard that cycling has a high incidence of infertility in men'. The female focus group held similar views, agreeing that the only time they've researched male fertility is 'maybe just once when there was the news about the male contraceptive' (F5).

The taboo nature and lack of discussion surrounding MRH, with all focus group participants stressing that 'we don't talk about private things like that' (F4), 'talking to my family members about it might be a bit weird' (F1) and 'it can be difficult to talk about with your close friends . . . it's not something people necessarily want to be known' (F1).

Theme 5: Increased information seeking and MRH discussion as age increases

A clear change in attitude was observed in the participants' responses when considering how they felt their opinions regarding MRH would change in 10 years' time, i.e. when participants reached 28–35 years of age. The men made it clear that they would be 'prepared to change a lot to make sure I had the best chances' (M2), both for themselves and for their partner – 'if [my partner] definitely wanted biological kids then I would make a lot of sacrifices' (M1). The female focus group felt they would seek out more information and be 'more likely to seek medical help' (F4).

DISCUSSION

This study investigated the gaps in awareness surrounding the associations between gym lifestyle factors, protein supplementation and MRH in a young adult population. The volume of responses to the questionnaire in such a short time demonstrated an overall interest in the topic, yet 100% of the focus group participants had never sought information on MRH or infertility – crucially highlighting the lack of awareness of this important topic. This is reinforced by the questionnaire analysis revealing that the majority of participants had not thought about their fertility before, but would be curious to know their fertility status.

A common theme that has emerged from this analysis is that there is a general failure to consider MRH as an important lifestyle factor. There appears to be a gap between men's desire for their own genetic children and their cognisance of their own fertility. Previous studies have highlighted the perception of fertility as a 'female issue' (*De Jonge et al., 2023*; *Grace et al., 2019*;

Slauson–Blevins and Johnson, 2016; *Stevenson et al., 2021*); it is interesting to note not only that is this finding echoed here, but also that women are shown to be primarily sought after for information sharing regarding reproductive health, even from the men in this study. The participants in this study highlighted that, in their view, the visibility of women's health (through periods and common female reproductive health concerns such as PCOS and endometriosis), and the corresponding lack of equivalent male talking points, creates a pathway to conversations on female reproductive health that is absent for men. This disparity suggests that there is a space for education surrounding the male role in reproduction to form more balanced discussions.

The focus groups highlighted the potential for social media to drive awareness, although a need for caution regarding the verifiability of advice was evident. This has been shown to be an effective tool in other studies, where the use of an informative mobile health app has been able to significantly improve men's awareness of infertility risk factors (*Kruglova et al., 2021*). Focus groups from another study have highlighted social media as an effective tool in spreading fertility information (*Hammarberg et al., 2017*). As shown in this present work, however, it is crucial that the use of social media to increase knowledge and awareness of MRH is accompanied by transparency surrounding the source of information to enhance trust and believe in the recommendations provided.

The survey revealed a significantly increased awareness of the impact of anabolic steroids on MRH compared with other supplement or lifestyle factors, agreeing with the levels of awareness of the impacts of steroid usage that have been shown in previous studies (*Daumler et al., 2016*). Awareness of the potential impacts of protein supplementation, however, was lowest among all the factors investigated, thereby providing a candidate for focusing educational efforts going forward. The prevalence of protein supplementation in the population studied (79% of men, 56% of women) was much greater than previously reported figures (closer to 23% of men; *Mintel, 2016*), indicating either a general increase in usage or that the survey population is more likely to use supplementation than the general populace. This prevalence, together with the lack of good-quality evidence for the effect of protein supplementation on men (*Ketheeswaran et al., 2019*, *2020*), reveals a demonstratable need for studies to understand the potential impacts on sperm parameters in healthy men.

It is notable that much of the work into masculinity focuses on behaviours that the general public believe hold a negative association, such as narcotic use of obesity (*Gordon et al., 2013*; *Griffith et al., 2018*). Understanding in more depth how young men balance the potential negative aspects of certain supplements against masculinity will in itself be important future work.

Overall, this work has demonstrated the need for two significant avenues of future work: first, a better understanding of the impacts of the most commonly used protein supplements on long-term MRH; and second, an educational awareness campaign targeted at young, gym-going men to improve awareness of their fertility and to highlight that, although their fertility may not be their immediate concern, some actions (e.g. smoking or protein supplement use) can have longer term impacts. The authors believe that it is only through approaching the problem from both scientific and educational perspectives that a greater appreciation of MRH can be achieved.

AUTHORS' ROLES

All authors contributed to study design, analysis and critical discussion of the work, and approved the manuscript. J.C.K.-B. conceived the research, co-supervised the project, and co-wrote the manuscript. M. T.G. conceived the research, supervised the project and co-wrote the manuscript.

DATA AVAILABILITY

The manuscript contains a link to the data

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DATA STATEMENT

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STUDY STRENGTHS AND LIMITATIONS

A strength of this study is the inclusion of the perspectives of both men and women, with both quantitative and qualitative approaches, allowing for a direct comparison of the perspectives of the two groups. The focus group approach, rather than static interviews, allowed for an interaction between the participants, thereby providing greater insight into their views and allowing them to explore avenues of thought while minimizing bias from researcher interjections.

The level of education of the participants and the single geographical location were major limiting factors of the study. Previous evidence has shown a positive correlation between education level and fertility awareness (*Pedro et al., 2018*; *Swift and Liu, 2014*), and thus the focus groups and questionnaire data may not accurately represent attitudes to and awareness of MRH in wider society. The low variation in the ages of the questionnaire and focus group participants was also a limiting factor. Attitudes and awareness would be more accurately represented by participants across a wider spectrum of ages, particularly given the changes in attitudes that the focus group participants felt they would have as they aged.

The participants of this study were largely self-selecting, and as such they may have a higher baseline awareness of reproductive health than the general population. The authors believe that these findings motivate the need for a wider characterization of both protein supplement usage and awareness of potential issues in this area. Educational resources are clearly needed to target the gym-going young adult population.

APPENDIX A – SURVEY QUESTIONS

A1 - Questionnaire shown to male respondents

1. What is your natal sex (sex assigned at birth)?

   ☐ Male

   ☐ Female

   ☐ Other

2. How old are you?

   ☐ < 18

   ☐ 18 – 25

   ☐ 26 – 33

   ☐ 33 – 40

3. On average, how many hours of exercise do you undertake per week?

   ☐ Under 1 hour / week

   ☐ 1 – 2 Hrs / week

   ☐ 3 – 5 Hrs / week

   ☐ 6 – 9 Hrs / week

   ☐ 10 – 15 Hrs / week

   ☐ 16 – 20 Hrs / week

   ☐ > 20 Hrs / week

4. Is this exercise performed in the gym or elsewhere?

   ☐ Gym

   ☐ Elsewhere

   ☐ Mix of both

5. Have you ever used anabolic steroids (e.g. testosterone or testosterone boosting) supplements?

   ☐ Yes

   ☐ No

5a. (Shown if 5 is Yes) What is the reasoning behind you taking these supplements?

   ☐ Muscle gain

   ☐ Weight loss

   ☐ Injury recovery

   ☐ Additional nutrition

   ☐ Other (please specify below)

6. Do you/have you ever used protein supplements (e.g. protein powder/shakes, bars, tablets or drinks)?

☐ Yes

☐ No

6a. (Shown if 6 is Yes) What is the reasoning behind you taking these supplements?

☐ Muscle gain

☐ Weight loss

☐ Injury recovery

☐ Additional nutrition

☐ Other (please specify below)

7. Please tick the box that most accurately represents how much you agree with the list of statements on the left.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have thought about my fertility before.					
My personal fertility is important to me – I would want the possibility of my own genetic children.					
I would be curious to know my personal fertility / sperm count.					
I know that some forms of high intensity exercise (e.g., weightlifting and cycling) have allegedly been associated with negative effects on male infertility.					
I have thought about the consequences of gym routines and supplements on male fertility.					
I know that protein shakes/supplements may have a negative effect upon my sperm quality.					
I know that anabolic steroid supplements (e.g., testosterone) can have a negative impact on male reproductive health.					
I know that some protein supplements (e.g., protein powders) have been found to be contaminated with anabolic steroids (e.g., testosterone).					
I think I would alter my gym/supplement behaviour if I knew it had a long-term effect on my fertility.					
At the moment I think that the benefits of gym and supplements are more important to me than fertility.					

A2 - Questionnaire shown to female/other respondents

1. What is your natal sex (sex assigned at birth)?

☐ Male

☐ Female

☐ Other

2. How old are you?

☐ < 18

☐ 18 – 25

☐ 26 – 33

☐ 33 – 40

3. On average, how many hours of exercise do you undertake per week?

   ☐ Under 1 hour / week

   ☐ 1 – 2 Hrs / week

   ☐ 3 – 5 Hrs / week

   ☐ 6 – 9 Hrs / week

   ☐ 10 – 15 Hrs / week

   ☐ 16 – 20 Hrs / week

   ☐ > 20 Hrs / week

4. Is this exercise performed in the gym or elsewhere?

   ☐ Gym

   ☐ Elsewhere

   ☐ Mix of both

5. Do you/have you ever used protein supplements (e.g. protein powder/shakes, bars, tablets or drinks)?

   ☐ Yes

   ☐ No

5a. (Shown if 5 is Yes) What is the reasoning behind you taking these supplements?

   ☐ Muscle gain

   ☐ Weight loss

   ☐ Injury recovery

   ☐ Additional nutrition

   ☐ Other (please specify below)

6. Please tick the box that most accurately represents how much you agree with the list of statements on the left.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I know that some forms of high intensity exercise (e.g., weightlifting and cycling) have allegedly been associated with negative effects on male infertility.					
I know that protein shakes/supplements may have a negative effect on sperm quality.					
I know that anabolic steroid supplements (e.g., testosterone) can have a negative impact on male reproductive health.					
I know that some protein supplements (e.g., protein powders) have been found to be contaminated with anabolic steroids (e.g., testosterone).					

APPENDIX B – FOCUS GROUP DISCUSSION PROMPTS

1. What research do you do before making health informed adaptations to your lifestyle? E.g., eating less red meat or taking vitamin supplements. Feel free to use personal examples if you feel comfortable.
2. What do you find the most engaging forms of healthcare communication are?
3. What springs to mind when considering infertility/reproductive health? Imagine you're creating a mind-map.
4. Have you ever sought information on male infertility/male reproductive health?
5. Would you feel uncomfortable talking to others about male infertility?
6. 6a. (Men only): How do you think your attitudes would change towards male fertility/reproductive health in, let's say, a decade (aged 30+)? In grey phase/actively trying for a baby phase, or seeking donor eggs.
7. 6b. (Women only): How do you think your attitudes would change towards male fertility/reproductive health in, let's say, a decade (aged 30+)? In grey phase/actively trying for a baby phase, or seeking donor sperm.

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