BMJ Open Sport & Exercise Medicine

Development and evaluation of an ovarian hormone profile classification tool for female athletes: step one of a two-step process to determine ovarian hormone profiles

Kirsty J Elliott-Sale ,[1] Laurence P Birdsey,[1] Richard J Burden ,[1,2] Nigel T Cable,[1] Emma Clausen,[1] Alysha C D'Souza,[3] Thomas Dos'Santos,[1] Adam Field,[1] Tessa R Flood ,[1] Rachel Harris,[4,5] Alan McCall,[6,7] Kelly L McNulty,[8] Niamh Ní Chéilleachair,[9,10] Ciaran O'Catháin,[9,10] Stuart M Phillips,[3] Glenn Sherwin,[1] Georgina K Stebbings ,[1] Bernadette C Taim,[9,10] Derrick W Van Every,[3] Joanna Więckowska,[1] Clare Minahan[4,11]

To cite: Elliott-Sale KJ, Birdsey LP, Burden RJ, *et al*. Development and evaluation of an ovarian hormone profile classification tool for female athletes: step one of a two-step process to determine ovarian hormone profiles. *BMJ Open Sport & Exercise Medicine* 2024;**10**:e002304. doi:10.1136/bmjsem-2024-002304

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/bmjsem-2024-002304).

Accepted 24 October 2024

For numbered affiliations see end of article.

Correspondence to
Professor Kirsty J Elliott-Sale; k.elliott-sale@mmu.ac.uk

ABSTRACT

Objective This study aimed to develop a reliable, comprehensive and fit-for-purpose tool for classifying ovarian hormone profiles (OHPs) (step one of a two-step process) in postmenarcheal to perimenopausal female athletes.

Methods The OHP classification tool was designed by a team of sport scientists, practitioners and medics and is intended for use by sport practitioners. It incorporates self-reported data and guides subsequent verification methods. Written feedback was received from practitioners currently working with elite female athletes (n=5), ensuring its applicability in an applied sport setting. In addition, inter-user (n=2) and intra-user (n=30) repeatability was assessed.

Results All practitioners agreed that the online tool was user-friendly. Four (out of five) practitioners stated they would include the tool in their practice, with the fifth stating that they did not have the capacity to incorporate it in their practice at present. The OHP classification tool showed excellent test–retest reliability with Cronbach's alpha values exceeding 0.9.

Conclusion This tool facilitates the classification of OHPs and promotes discussions between athletes and practitioners, enhancing understanding and management of ovarian hormone health in sportswomen.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Oestrogen and progesterone affect the musculoskeletal, cardiovascular and cognitive systems, which have the potential to impact athletic performance. The classification and monitoring of ovarian hormone profiles (OHPs) in female athletes remains challenging, as athletes and their support teams may lack awareness of how to accurately assess and interpret hormonal changes or understand their implications.

WHAT THIS STUDY ADDS

⇒ This first of its kind classification tool provides a robust, comprehensive and standardised method for classifying the most commonly experienced OHPs in elite female athletes. This OHP classification tool provides the first step in a two-step process for determining the OHPs of female athletes using a high-quality scientific approach.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ By using this OHP classification tool, practitioners can better support female athletes in optimising their health and performance, making it an essential resource in the sports science field.

INTRODUCTION

The ovarian hormones—oestrogen and progesterone—have reproductive functions, which are related to health, and non-reproductive functions (eg, musculoskeletal, cardiovascular and cognitive[1]), which might affect athletic abilities and injury risk. This makes ovarian hormone profiles (OHPs) a significant topic of interest in sport and an important consideration for sportswomen. Female athletes can experience a variety of ovarian hormone profiles,[2–6] which can change over time, including eumenorrhoea, amenorrhoea, cyclical hormonal contraception, long-acting reversible contraception. However, these specific OHPs are not always evident to the athlete or their support staff (eg, coaches, sports scientists, clinicians, nutritionists). While sportswomen may be aware of certain aspects of their OHP, such

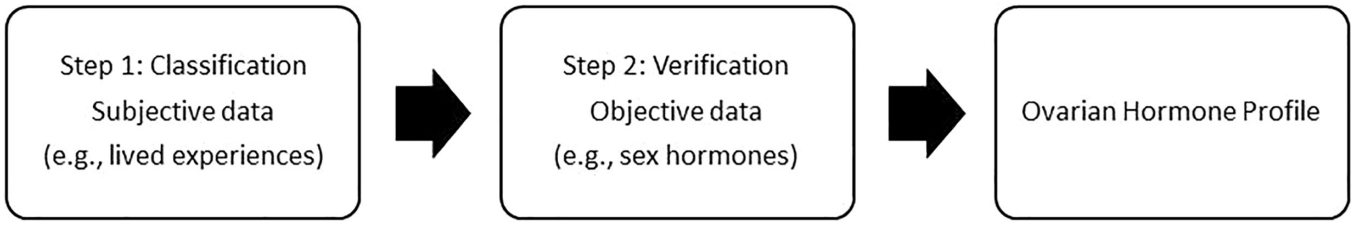

Figure 1 Two-step process for the determination of ovarian hormone profiles in female athletes.

as the absence or frequency of menstruation, they often do not fully understand which OHP these characteristics represent or the implications of each profile. For example, some female athletes who menstruate every 20 days may not realise that this represents abnormal rather than normal uterine bleeding. Moreover, the timing of key physiological events, such as ovulation or the mid-luteal rise in progesterone, are not as easily discernible as menstruation, meaning that OHPs need to be established by a combination of subjective (eg, lived experiences) and objective (eg, circulating hormone concentrations) data.[7]

To effectively manage their health and performance, female athletes, with the support of their sports science and medicine staff, must first classify their OHPs using self-reported subjective data. Following this initial classification, an appropriate system should be employed to verify these profiles using objective data. As such, a two-step process is needed to establish the OHP of sportswomen (figure 1). Once the OHP of a female athlete has been established, the effects of different OHPs on athletic performance (or determinants of athletic performance) or injury risk (or mechanobiological surrogates of injury risk) can be investigated. The aim of this study was to develop a classification tool for postmenarcheal to perimenopausal female athletes, which can be used to determine the appropriate method for subsequent OHP verification, representing the first stage in a two-step process to establish the OHP of female athletes.

METHODS

Operational definitions

The following dictionary (Oxford Languages) definitions were employed: (1) *classify* (verb): arrange (a group of people or things) in classes or categories according to shared qualities or characteristics; (2) *verify* (verb): make sure or demonstrate that (something) is true, accurate or justified; and (3) *establish* (verb): achieve permanent acceptance or recognition for. The terms *profile* and *status* were used interchangeably to denote the ovarian hormone condition of the athletes. The phrases *female athletes* and *sportswomen* were used to describe cisgender women.

In order to aid with the transition from the 'previous' to the 'replacement',[8] terminology for abnormal uterine bleeding (AUB), both terminology have been provided throughout this manuscript as well as in the tool and associated documents: (1) oligomenorrhoea and AUB-infrequent; (2) anovulation and AUB-O; (3) luteal phase defect and AUB-E; and (4) polymenorrhoea and AUB-frequent. All nomenclature used in relation to OHPs (eg, eumenorrhoea, amenorrhoea) is defined in a study by Elliott-Sale *et al*.[9]

Development of the OHP classification tool

The OHP classification tool was developed in two formats, namely an infographic and an online form. The infographic (online supplemental file 1) allows users to view the entire tool in one place, while the online form (Online Ovarian Hormone Profile Tool Link) allows users to interact with the questions in a user-friendly format. An operational document, including the scope of and instructions for the OHP classification tool, alongside a comprehensive list of operational definitions, was also developed to accompany the tool (online supplemental file 2). The tool was developed by emerging and experienced researchers, sport scientists (from high-performance sport, currently supporting elite female athletes) and a sports medicine doctor.

The content of the OHP classification tool and operational document (version 1) was initially devised by KE-S and subsequently reviewed and revised by RB, CM, RH, KLMN, EC, TF, GS, JW, ACD'S and DWVE (three cisgender men and eight cisgender women) resulting in version 2. This team reflects a diverse group of early and senior researchers, practitioners (from high-performance sport, currently supporting elite female athletes), from the UK, Australia and Canada, many of whom have a proven history in this research area and all of whom have first-hand experience researching and working with female athletes. The second version was reviewed by an independent group comprising sports scientists and clinicians (ie, 'practitioners') and subsequently revised in response to their feedback, resulting in version 3. The third version was used to assess inter-user and intra-user repeatability. Version 3 is the finalised tool presented here. The infographic was produced by KLMN. There was no public or patient involvement in this study.

Scope of the OHP classification tool

The OHPs included in this tool are not exhaustive but incorporate the 38 most common OHPs observed in elite female athletes.[10] This tool is designed for use in athletes who have reached menarche (ie, usually aged around 12 years) or are aged 15 years or older (ie, the age by which menarche is expected to have occurred) and who have

not yet entered perimenopause. The perimenopausal transition is outside of the scope of the OHP classification tool and warrants its own classification and verification systems. As such, this tool is applicable for most female adolescent and adult (up to Masters—aged 35 years and above) athletes.

The OHP classification tool is practitioner-led, meaning that practitioners are intended to use it with their athletes, rather than athletes using it themselves. We acknowledge that not all female athletes have access to a multidisciplinary team, including sport science and medical staff, and in such cases, we suggest that these athletes either engage with their general practitioner for advice on their ovarian hormone status or consult with a suitable practitioner for this specific activity if their circumstances allow for this. Please note that this tool can be used in both applied and laboratory settings. Here, we have focused on practitioners and athletes in an applied setting, but it should be noted that this tool is also applicable to researchers and female participants in laboratory studies.

Design of the OHP classification tool

Given the OHP classification tool and accompanying documents are included in this paper, only a brief description of the process is provided here. The tool is a flowchart system with a series of 'yes' and 'no' questions. For some classifications, there are additional questions to provide extra detail about the athlete's self-reported profile. We suggest using the online version of the OHP classification tool rather than the infographic. However, we recommend that users (practitioners) familiarise themselves with the flow of the classification tool and the order of questions using the infographic, where the entire tool is visible in one place. Users should work through all the relevant questions with the athlete until they reach an OHP classification, which is accompanied by an action point and QR code. The action point provides advice on whether to begin tracking the athlete's ovarian hormonal status, which is the next step in the OHP verification process. The ovarian hormonal status tracking guides provide advice on how tracking could be undertaken. The tracking guides should be considered as suggestions rather than directives, as there is currently no consensus on the best approach (ie, gold standards) to ovarian hormone status tracking in elite sport. Notwithstanding this, several guidance papers are available[7 9 11–13] on various aspects of ovarian hormone status tracking, which have been used to underpin the tracking guides included with this tool.

The OHP classification tool can be used at any time; however, we suggest using it (1) when working with a female athlete for the first time; (2) as part of an annual/routine monitoring, screening or physical assessment battery; (3) at random times throughout the season/calendar year to identify any changes in OHP since the previous assessment; and (4) at least 3 months after a female athlete reveals a change of circumstance (eg, they have stopped using their hormone contraceptive or given birth). Other considerations regarding when and how to use this tool are provided in the operational document.

User (practitioner) feedback

Five practitioners (two cisgender men and three cisgender women; one sport and exercise medicine consultant and four physiologists), currently working in high-performance sport in the UK with elite female athletes, volunteered to take part in this aspect of the study, which had institutional ethical approval from Manchester Metropolitan University. All practitioners provided written informed consent before being provided with version 2 of the infographic, online tool and operational document. Practitioners were asked six questions in total. Three questions used Likert scales from 1 'not at all' to 4 'entirely' to rate how easily they could follow the tool and whether the language and terminology were appropriate. Three questions were dichotomous 'yes' or 'no' questions, which asked if the instructions provided in the operational document helped them use the tool; whether the online tool was user-friendly, and if they would incorporate the tool into their practice. Lastly, practitioners were provided with an opportunity to provide additional feedback (ie, free text box). All feedback received from practitioners (table 1) was considered and used to revise the OHP classification tool, resulting in version 3 of the tool.

Inter-user and intra-user repeatability

30 apparently healthy cisgender women (aged 26±5 years) volunteered for this aspect of the study. There were no constraints on the athletic calibre of the participants who volunteered; they were a mixture of sedentary and active women. Participants were recruited via flyers (distributed in the local areas and universities) and word-of-mouth; 15 were assessed at Manchester Metropolitan University, UK, and 15 were assessed at McMaster University, Canada. This aspect of the study had institutional ethical approval from Manchester Metropolitan University and McMaster University, and all participants provided written informed consent. A sample size of 28 was calculated (https://wnarifin.github.io/ssc/ssalpha.html) based on a minimum acceptable Cronbach's alpha of 0.74 and an expected value of 0.90. Each participant attended three sessions with a minimum of 48 hours between sessions. During each session, participants were independently assessed using version 3 of the tool by two researchers (ie, raters), separated by a 5 min break between assessments. All raters were researchers with experience in this topic (ie, OHPs) and are coauthors of this paper (GS, JW, ACD'S and DWVE). The order of researchers was randomised prior to each session using a free online tool (https://numbergenerator.org/). Before attending sessions, participants were provided with a standardised briefing asking them not to share any details of their OHP with the researchers until the testing sessions. Participants were also asked to treat each session

Table 1 User (practitioner) feedback to the six closed questions

Questions	1 'not at all'	2 'somewhat'	3 'mostly'	4 'entirely'
Could you easily follow the ovarian hormone classification tool?	0	0	2 M=0 W=2	3 M=2 W=1
Do you think the language used within the classification tool is appropriate (ie, the way the ovarian hormone tool is phrased)?	0	0	3 M=1 W=2	2 M=1 W=1
Do you think the terminology used within the classification tool is appropriate (ie, the specialist/technical terms relating to ovarian hormone profiles)?	0	0	4 M=1 W=3	1 M=1 W=0
	No		**Yes**	
Did the instructions help you to use the ovarian hormone classification tool?	0		5 M=2 W=3	
Was the online ovarian hormone classification tool user-friendly?	0		5 M=2 W=3	
Would you incorporate the online ovarian hormone classification tool into your practice with female athletes?	1 M=0 W=1		4 M=2 W=2	

Data are presented as the number of practitioners per response along with the breakdown of the responses based on the sex of the practitioners.
M, cisgender men; W, cisgender women.

as an independent session and solely provide information about the exact questions asked during each session.

Statistical analysis

Cronbach's alpha (α) was calculated using SPSS (IBM SPSS Statistics, V.29) to assess the inter-user (ie, between) and intra-user (ie, within) repeatability. A Cronbach's alpha of ≥0.74 was considered acceptable.[14] Each classification was coded with a number from 1 to 38 to aid analysis.

RESULTS

User (practitioner) feedback

Table 1 shows the categorical responses to the six standard feedback questions by the practitioners. In response to question 1, related to whether they could follow the OHP classification tool, practitioners rated that they could 'mostly' or 'entirely' follow the tool. Participant 4 (cisgender man): 'At first, opening up the infographic was a little overwhelming with lots of options and different directions the answers provided. But, it was a useful resource to have an overview of the tool and understand the flow of the questions.'

In response to questions 2 and 3, practitioners rated the language (ie, the way the OHP classification tool is phrased) and terminology (ie, specialist/technical terms relating to OHPs) as 'mostly' appropriate or 'entirely' appropriate.

Participant 5 (cisgender woman): 'Ovarian hormone profile is not very athlete friendly, but appreciate that is the point to start to get athletes to use right terminology?'

All practitioners stated that the instructions helped them to use the tool and that the current format was user-friendly.

Participant 3 (cisgender man): 'The online form was very straight forward to follow and is user-friendly. The supporting guidance and terminology are needed in order to understand and get the best out of the tool—potentially this could be incorporated into the online tool so it's all in one place, especially to develop the ease-of-use. There are clear actions when completing which are very easy to understand. Overall, an effective tool.'

Four practitioners said that they would incorporate the online tool into their practice, while one practitioner said they would not.

Participant 2 (cisgender woman): 'In an ideal world, of course, we would collect this information along with many other variables. However, I don't currently have enough capacity to ensure the actions from the profiling tool are completed, analysed and followed up. At current, this topic would be lower down the priority list unfortunately. I would consider using this tool if an athlete expressed an issue associated to menstrual function or in relation to another issue (eg, under-fuelling) to provide further context as part of a case formulation. If an athlete also reports no issue with menstrual cycle/hormonal contraceptive use I would struggle to advocate the data being collected if no actions are needed. It is often difficult to get athletes in a routine of self-reporting things unless it is acted upon. The tool feels like a nice to have rather than essential to our screening process.'

Table 2 shows the additional (ie, free text box) feedback provided by the practitioners and the actions taken by the research team to address these comments.

Inter-user and intra-user repeatability

108 self-reported OHP classifications were generated during the inter-user and intra-user repeatability

Table 2 Practitioner feedback and actions taken to develop version 3 of the classification tool

Practitioner number: sex	Verbatim feedback	Action
Feedback on specific content		
Practitioner 1: cisgender woman	Breastfeeding—would recommend tracking cycle even if breastfeeding. It's important we know when the cycle returns as many have delayed resumption due to low energy availability. Breastfeeding can also temporarily reduce bone mineral density and so amenorrhoea.	No action was required as this information was already included.
Practitioner 1: cisgender woman	Postpartum—this may be confusing as initially a woman has lochia bleeding for several weeks and so asking if bleeding is normal could be conflicting.	A sentence was added to the operational document to address this.
Practitioner 1: cisgender woman	Need to stipulate what we mean by testing for ovulation, that is, urine or blood.	A sentence was added to both the online tool and operational document to provide additional detail.
Practitioner 1: cisgender woman	Question on the type of pill (mono/bi/triphasic, etc)—athletes generally do not know this and I would say that many sports docs (that are not GPs) would not necessarily have knowledge. Does this information give us relevant information, as I would think just knowing whether estrogen+progesterone or progesterone only is the most relevant.	No action was required as this information was already included.
Practitioner 5: cisgender woman	Question asking if HC contains estrogen+progesterone—would suggest adding such as 'the combined pill'—athletes are often unaware of pill types. Hormonal contraceptives contain oestrogen and progesterone. This question all of the athletes might not understand, know answer to—so potentially a help function to find out? that is, a hint to look at the infographic as explains the options.	Examples were added to the online tool and operational document.
Practitioner 5: cisgender woman	Pills—21 days or 28 days. This question might need a 'both' option. They usually do 21 but sometimes 28 if they have a comp, for example.	Instead of providing a 'both' option, additional details were provided in the operational document detailing what to do in this and other similar circumstances.
Practitioner 5: cisgender woman	Bleeding pattern—what if the athlete has both long and short cycles? maybe an option for both.	Additional details were provided in the operational document detailing what to do in this and other similar circumstances.
Practitioner 5: cisgender woman	Never menstruated—Unsure why the option is to track if they never have? Should it be reworded as to when you start?	The wording was changed on the online tool and infographic to state that tracking starts once the athlete has experienced their first bleed.
Feedback on tool usability and design		
Practitioner 3: cisgender man	The supporting guidance and terminology are needed in order to understand and get the best out of the tool—potentially this could be incorporated into the online tool so it's all in one place, especially to develop the ease-of-use.	A sentence was added at the beginning of the online tool recommending that practitioners have the operational document, containing all relevant definitions, open alongside the tool. Definitions were also added to the online tool in situ.
Practitioner 4: cisgender man	Working through the flow chart in the infographic, after the relevant questions have been asked, I would suggest drawing more attention to the 'ovarian hormone classification', perhaps using a different font or coloured boxes. I felt the classifications merged in with the questions a little.	The ovarian hormone classifications in the infographic were given a different colour to draw more attention to them.

Continued

Table 2 Continued

Practitioner number: sex	Verbatim feedback	Action
Practitioner 4: cisgender man	Infographic—is there a difference between the full lines and dotted lines in the infographic?	There were no differences between the full and dotted lines; therefore, in order to simplify the infographic, we removed the dotted lines and used full lines only.
Practitioner 4: cisgender man	Infographic—a key might make it more user-friendly, for example, green=action.	A key was added to the infographic to make it more user-friendly.
Practitioner 4: cisgender man	The online tool also provides QR codes (at the green action boxes on the infographic). Should the green sections on the infographic link to anything?	The QR codes were added to the infographic.
Practitioner 4: cisgender man	Good to have advice on what to think about and prepare before, including the generic athlete briefing paragraph which is useful. My only thought on this was that could you make it clearer whether the practitioner should work through the tool alongside the athlete or hand over the tool (google doc link) to the athlete and leave them to it in their own time. It is spoken about but, for me, it could have been clearer!	Additional details were provided in the operational document to highlight that the tool is practitioner led.
Feedback on data protection and privacy		
Practitioner 2: cisgender woman	How will you ensure data protection for athletes/support staff using the online tool? I wouldn't feel comfortable using this system when the data is housed outside of my organisation. There is no description of where/how it is being stored and who has access.	Details on data protection were added to the operational document.

GPs, general practitioners; HC, hormonal contraception.

assessment (figure 2). It took approximately 5 min to complete the classification process with each participant. There were three discrepancies noted in self-reported OHP classifications which are detailed in table 3. Table 4 shows that overall, the inter-user and intra-user repeatability of the OHP classification tool was excellent with Cronbach alpha values all higher than 0.9

DISCUSSION

Summary of findings

Here we have developed, for the first time, an online and paper-based OHP classification tool for use in postmenarcheal to perimenopausal female athletes. The feedback from a group of sport practitioners currently working with elite female athletes was positive and the tool showed excellent inter-user and intra-user repeatability. We therefore believe that the adoption of this tool will have a significant impact on how OHPs are considered within sport.

Unintended findings

The qualitative feedback provided by the end-users offered insights into the mindset of and challenges faced by some practitioners in the applied setting. First, the importance of using 'correct terminology' was highlighted; with one practitioner implying that it is time for athletes to start to recognise and use the correct terms, rather than continuing to use colloquial or incorrect phrasing. Second, 'environment' was emphasised; with one practitioner (the only one to state they would not incorporate the tool into their practice at present) describing their perceived barriers (eg, lack of capacity and priority) and facilitators (eg, using the tool with an athlete suspected of under fuelling) to OHP screening within their applied context. Lastly, 'bias' and 'unawareness' were indicated; with one practitioner indicating that the tool should only be used with athletes who 'expressed an issue associated to menstrual function', which highlights the potential bias in favour of menstrual cycle profiles to the exclusion of all others (eg, hormonal contraceptive use) and a lack of wider awareness and knowledge of subtle menstrual disturbances (ie, AUB-O and AUB-E). These unintended findings speak to the current landscape within elite sport with regard to ovarian hormone screening and highlight the need for further system-wide upskilling and resourcing.

Practical applications

This OHP classification tool is the first step in a two-step process to establish the ovarian hormone status of sportswomen; meaning that the classification generated by the OHP classification tool (step one) can be used to determine which verification process is needed in step two. Moreover, this tool provides guidance on which OHP tracking system could be used for each of the OHP classifications generated by the tool.

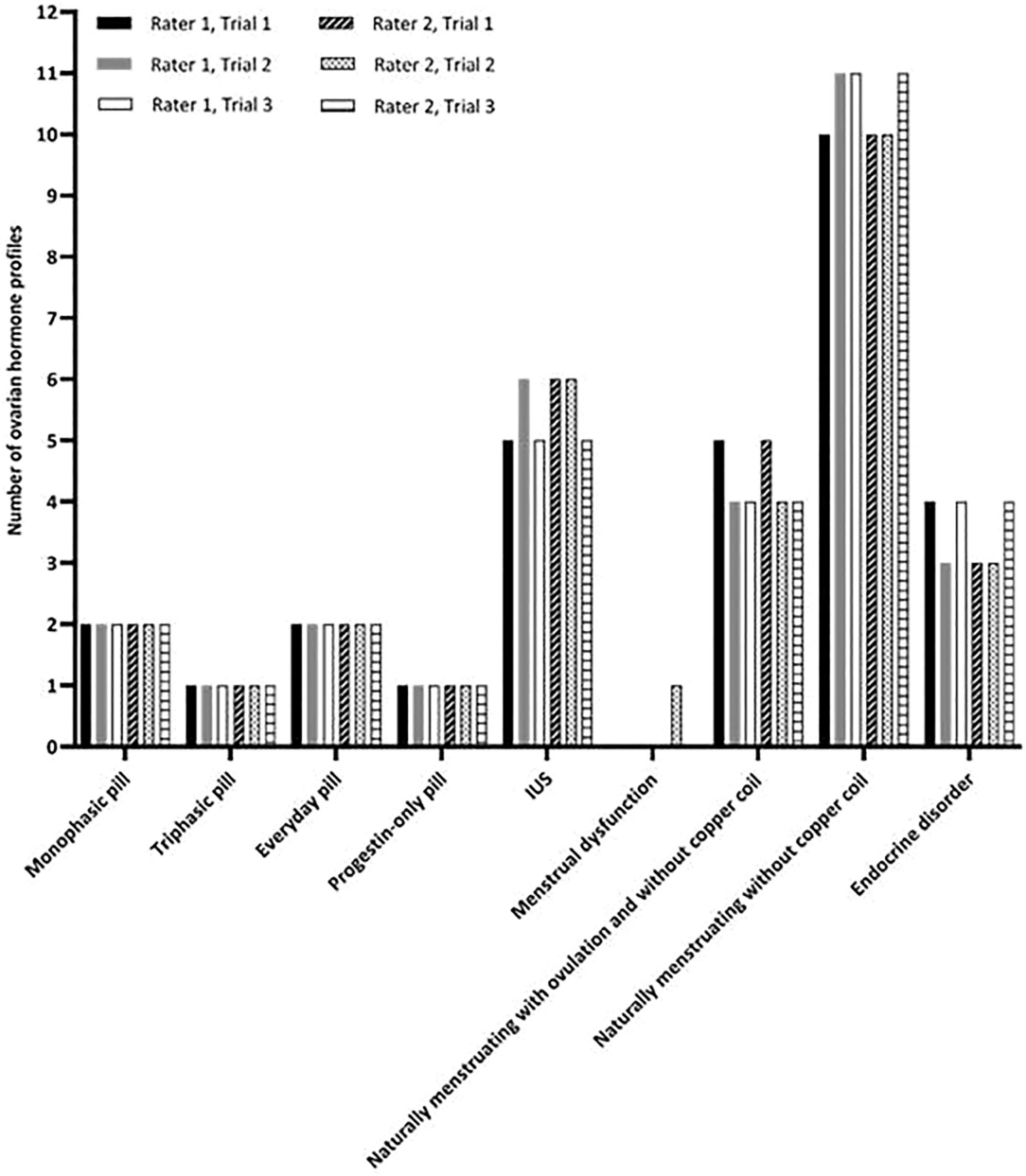

Figure 2 Number of self-reported ovarian hormone profile classifications across the three trials recorded by both raters. IUS, intrauterine system (hormonal coil).

The classification process by its very nature can also be used to enable discussion of and upskilling in OHPs for both the athlete and practitioner. We acknowledge that the information contained within or associated with the OHP classification tool may be new and unfamiliar to some practitioners/researchers, therefore we recommend that all practitioners/researchers should familiarise themselves with the infographic and operational document prior to using the online tool with their athletes. By using this tool, athletes and practitioners gain insights into their own/athletes' OHPs, which might otherwise have remained unconsidered and undiscussed. This tool is ideal for practitioners who are unsure about how to broach matters related to OHPs with their athletes (eg, menstruation or hormonal contraceptive use), as it facilitates both conversation and education (ie, body literacy) on topics that have historically been overlooked in sport settings.

Critical appraisal

The purpose of the inter-user and intra-user repeatability assessment was to determine whether the OHP classification tool could produce consistent responses when assessed under the same conditions by two independent users/raters. Participants volunteered for this assessment and were not preselected based on specific OHPs, thus representing a random sample from the population. We acknowledge that this method of sampling may be subject to volunteer bias, however, this is unlikely to affect the OHPs captured in this study. As such, the design of

Table 3 Discrepancies with the intra-user and inter-user repeatability

	Trial 1	Trial 2	Trial 3	Conclusions and rationales
Discrepancy one				
Rater 1	Endocrine disorder	IUS	Endocrine disorder	**Conclusion:** Inconsistency of participant response to the same question. **Rationale:** Question: Have you been diagnosed with any endocrine disorder? (Yes/No) ► 'Yes' response yields the classification of 'endocrine disorder', with no other classifications available. ► 'No' response has numerous follow-up questions leading to a myriad of classifications (including IUS). ► The participant was inconsistent with their answer to the question, sometimes stating they had an endocrine disorder and sometimes stating they did not.
Rater 2	IUS	IUS	Endocrine disorder	
Discrepancy two				
Rater 1	Naturally menstruating with ovulation without copper coil	Naturally menstruating without copper coil	Naturally menstruating without copper coil	**Conclusion:** Inconsistency of participant response to the same question. **Rationale:** Question: Do you have a copper coil fitted? (Yes/No) Follow-up question: Have you tested (in the last 6 months) if you ovulate or have sufficient progesterone for two or more cycles? ► Six possible answers based on the response to both questions combined. ► The participant gave a different answer to the follow-up question in trial 1 than in trials 2 and 3.
Rater 2	Naturally menstruating with ovulation without copper coil	Naturally menstruating without copper coil	Naturally menstruating without copper coil	
Discrepancy three				
Rater 1	Naturally menstruating without copper coil	Naturally menstruating without copper coil	Naturally menstruating without copper coil	**Conclusion** No issue
Rater 2	Naturally menstruating with ovulation without copper coil	Menstrual dysfunction	Naturally menstruating without copper coil	**Conclusion and rationale** Given that Rater 1 returned a consistent classification and Rater 2 returned three different classifications, it is most likely that the issue was with the practitioner's application of the tool (ie, selected wrong response or classification) or with the participants response (ie, they were inconsistent with their responses).

IUS, intrauterine system (hormonal coil).

this repeatability study allowed for the possibility for all 38 OHP classifications included within this tool to be 'assessed'. In actuality, nine distinct OHP classifications were assessed in this test–retest study and 29 classifications were not. Given the research design employed in this study (ie, random sampling and the possibility of assessing all classification permutations) there is no reason to suggest that the 29 OHP classifications that were not assessed would be more or less consistent than the nine classifications that were.

Table 4 Cronbach α for the inter-user and intra-user repeatability of the classification tool for Rater 1 (R1) and Rater 2 (R2)

Repeatability	Comparison	Cronbach α
Intra-rater	R1 Trial 1 vs R1 Trial 2	0.973
	R1 Trial 2 vs R1 Trial 3	0.973
	R2 Trial 1 vs R2 Trial 2	0.977
	R2 Trial 2 vs R2 Trial 3	0.951
Inter-rater	R1 Trial 1 vs R2 Trial 1	0.973
	R1 Trial 2 vs R2 Trial 2	0.977
	R1 Trial 3 vs R2 Trial 3	1.000

The three discrepancies shown in the inter-user and intra-user repeatability trials occurred in women not using hormonal contraceptives. These discrepancies demonstrate that, although this tool is capable of returning consistent inter-user and intra-user responses (as shown in the other 27 women), it remains a self-report tool that is subject to the usual pitfalls associated with self-reports; for an insightful discussion of this topic see a study by Brenner *et al*.[15] This tool, like other self-reports, relies on the user (practitioner) being accurate, impartial and consistent with its administration and the responder

(athlete) being informed, unbiased and truthful with their answers. This is why this tool is only the first step in a two-step process; with the second step using objective measurements for verification. If this tool is used in isolation, without subsequent verification, there is a chance that the athlete could be misclassified.

Self-report tools are validated by correlating their results with an objective measure. As such, validation is not relevant in this case, as our OHP classification tool is not intended to be used in isolation to establish an athlete's OHP. Rather, it is intended to be used in combination with objective measures. Indeed, the OHP classification tool identifies which verification approach (ie, objective measures) could be employed. For example, without the OHP classification tool, all sportswomen could be subjected to menstrual cycle phase verification (ie, calendar counting related to menstruation, ovulation confirmation and the assessment of mid-luteal progesterone), which would not be appropriate for hormonal contraceptive users, pregnant athletes, etc. Therefore, the OHP classification tool is an integral part of identifying which verification approach should be taken.

We cannot be certain that social desirability bias did not affect the practitioners' feedback responses. It should, however, be noted that all feedback were collected anonymously and we received comments that ranged from complete agreement to statements requiring revisions to the tool. It should also be noted that all practitioners who took part in this study already work with female athletes so may, therefore, have been more receptive to the tool.

We appreciate that other decision-making systems are available, however, this tool has numerous advantages to previous approaches:

1. It is the most comprehensive tool to date, covering more OHPs than any other system.
2. Its formats (infographic and online form) are more user-friendly than previous arrangements using multiple, separate, paper-based diagrams.
3. It incorporates the most up-to-date terminology.[8]
4. It has been designed and authored by a diverse group of early and senior researchers, practitioners and clinicians (from high-performance sport, currently supporting elite female athletes), many of whom have a proven history in this research area and all of whom have first-hand experience researching and working with female athletes.
5. It has been reviewed and endorsed by a group of independent sport practitioners, currently working with elite sportswomen.
6. It has shown excellent inter-user and intra-user repeatability.
7. It is accompanied by a complete set of instructions and a list of operational definitions meaning that it is extremely user orientated.
8. Its interactive nature means it is both useful and engaging, resulting in an OHP classification plus an opportunity for athletes and practitioners to upskill on topics related to OHPs.
9. It has been underpinned by the current best practice guidelines in this field.[9]
10. It reinforces a high-quality approach to research and practice by promoting a combination of subjective and objective measures, as opposed to systems that rely on self-reported data only.

CONCLUSION

We have developed a user-friendly tool for the categorisation of OHPs that is both acceptable and reliable. We strongly encourage practitioners to establish OHPs by classifying their athletes in the first instance (ie, using this tool) and then employing a high-quality approach, using objective measurements, to verify ovarian hormone status. OHPs are an important indicator of reproductive health and may play a part in athletic performance (or aspects of performance such as injury, recovery, training adaptations, etc.), meaning that knowledge and understanding of female athletes' OHPs is vital.

Author affiliations
[1]Department of Sport and Exercise Science, Manchester Metropolitan University Institute of Sport, Manchester, UK
[2]United Kingdom Sports Institute, Manchester, UK
[3]Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada
[4]Female Performance and Health Initiative, Australian Institute of Sport, Canberra, Australian Capital Territory, Australia
[5]Perth Orthopaedics and Sports Medicine Research Centre, Perth, Western Australia, Australia
[6]Arsenal Performance and Research Team, Arsenal Football Club, London, UK
[7]School of Applied Sciences, Edinburgh Napier University, Edinburgh, UK
[8]Department of Sport, Exercise and Rehabilitation, Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, UK
[9]Department of Sport and Health Sciences, Technological University of the Shannon: Midwest Midlands, Athlone, Co Westmeath, Ireland
[10]SHE Research Centre, Technological University of the Shannon: Midlands Midwest, Athlone, Co Westmeath, Ireland
[11]Griffith Sports Science, Griffith University, Gold Coast, Queensland, Australia

X Kirsty J Elliott-Sale @ElliottSale, Richard J Burden @rich_burden, Tessa R Flood @tessflood and Clare Minahan @clareMINAHAN

Acknowledgements We would like to acknowledge the practitioners who took the time to provide detailed feedback, which contributed to the development of the tool.

Contributors The tool was initially devised by KE-S and subsequently reviewed and revised by RB, CM, RH, KLMN, EC, TF, GS, JW, ACD'S and DWVE. All authors reviewed, edited and approved the final submission. KE-S is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Manchester Metropolitan University, UK (EthOS ID 64926) and McMaster University, Canada (MREB#: 7204). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The data, generated as part of the inter-user and intra-user repeatability portion of the study, are available upon request.

ORCID iDs
Kirsty J Elliott-Sale http://orcid.org/0000-0003-1122-5099
Richard J Burden http://orcid.org/0000-0002-2811-5454
Tessa R Flood http://orcid.org/0000-0001-8897-0957
Georgina K Stebbings http://orcid.org/0000-0003-0706-2864

REFERENCES

1 Manolagas SC, Kousteni S. Perspective: nonreproductive sites of action of reproductive hormones. *Endocrinology* 2001;142:2200–4.
2 Martin D, Sale C, Cooper SB, *et al*. Period Prevalence and Perceived Side Effects of Hormonal Contraceptive Use and the Menstrual Cycle in Elite Athletes. *Int J Sports Physiol Perform* 2018;13:926–32.
3 Parker LJ, Elliott-Sale KJ, Hannon MP, *et al*. An audit of hormonal contraceptive use in Women's Super League soccer players; implications on symptomology. *Sci Med Footb* 2022;6:153–8.
4 Nolan D, Elliott-Sale KJ, Egan B. Prevalence of hormonal contraceptive use and reported side effects of the menstrual cycle and hormonal contraceptive use in powerlifting and rugby. *Phys Sportsmed* 2023;51:217–22.
5 Taim BC, Ó Catháin C, Renard M, *et al*. The Prevalence of Menstrual Cycle Disorders and Menstrual Cycle-Related Symptoms in Female Athletes: A Systematic Literature Review. *Sports Med* 2023;53:1963–84.
6 Heyward O, Elliott-Sale KJ, Roe G, *et al*. Oral contraceptive use in Premiership and Championship women's rugby union: perceived symptomology, management strategies, and performance and wellness effects. *Sci Med Footb* 2024;8:95–102.
7 Burden RJ, Altini M, Ferrer E, *et al*. Measure do not guess: a call to action to end assumed and estimated menstrual cycle phases in research. *BMJ Open Sport Exerc Med* 2024;10:e002095.
8 Oleka CT, Anderson T, Ackerman KE, *et al*. An update to terminology describing abnormal uterine bleeding in female athletes: facilitating cross-disciplinary health care. *Br J Sports Med* 2024;58:1237–9.
9 Elliott-Sale KJ, Minahan CL, de Jonge XAKJ, *et al*. Methodological Considerations for Studies in Sport and Exercise Science with Women as Participants: A Working Guide for Standards of Practice for Research on Women. *Sports Med* 2021;51:843–61.
10 Adam MEK, Bristow A, Neely KC, *et al*. Do women athletes' experiences of menstrual function and dysfunction vary across competition levels? A mixed methods exploration. *Psychol Sport Exerc* 2022;63:102270.
11 Janse DE Jonge X, Thompson B, Han A. Methodological Recommendations for Menstrual Cycle Research in Sports and Exercise. *Med Sci Sports Exerc* 2019;51:2610–7.
12 Noordhof DA, Taylor MY, De Martin Topranin V, *et al*. Agreement Between the 2- and 3-Step Methods for Identifying Subtle Menstrual Disturbances. *Int J Sports Physiol Perform* 2024;19:953–7.
13 Ferrer E, Rodas G, Casals G, *et al*. The use of saliva and blood progesterone to profile the menstrual cycles of youth professional football players. *Front Sports Act Living* 2024;6:1430158.
14 George D, Mallery P. *SPSS for Windows Step by Step: A Simple Guide and Reference*. Allyn & Bacon, 2003.
15 Brenner PS, Lies DJ, Lies D, *et al*. Identity as a Cause of Measurement Bias. *Soc Psychol Q* 2016;79:333–54.