






Psychology and counselling

Women's interest, knowledge, and attitudes relating to anti-Mullerian hormone testing: a randomized controlled trial

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ABSTRACT

STUDY QUESTION: What is the impact of co-designed, evidence-based information regarding the anti-Mullerian hormone (AMH) test on women's interest in having the test?

SUMMARY ANSWER: Women who viewed the evidence-based information about the AMH test had lower interest in having an AMH test than women who viewed information produced by an online company selling the test direct-to-consumers.

WHAT IS KNOWN ALREADY: Online information about AMH testing often has unfounded claims about its ability to predict fertility and conception, and evidence suggests that women seek out and are recommended the AMH test as a measure of their fertility potential.

STUDY DESIGN, SIZE, DURATION: An online randomized trial was conducted from November to December 2022. Women were randomized (double-blind, equal allocation) to view one of two types of information: co-designed, evidence-based information about the AMH test (intervention), or existing information about the AMH test from a website which markets the test direct-to-consumers (control). A total of 967 women were included in the final analysis.

PARTICIPANTS/MATERIALS, SETTING, METHODS: Participants were women recruited through an online panel, who were aged 25–40 years, living in Australia or The Netherlands, had never given birth, were not currently pregnant but would like to have a child now or in the future, and had never had an AMH test. The primary outcome was interest in having an AMH test (seven-point scale; 1 = definitely NOT interested to 7 = definitely interested). Secondary outcomes included attitudes, knowledge, and psychosocial and behavioural outcomes relating to AMH testing.

MAIN RESULTS AND THE ROLE OF CHANGE: Women who viewed the evidence-based information about the AMH test had lower interest in having an AMH test (MD = 1.05, 95% CI = 0.83–1.30), less positive attitudes towards (MD = 1.29, 95% CI = 4.57–5.70), and higher knowledge about the test than women who viewed the control information (MD = 0.75, 95% CI = 0.71–0.82).

LIMITATIONS, REASONS FOR CAUTION: The sample was more highly educated than the broader Australian and Dutch populations and some measures (e.g. influence on family planning) were hypothetical in nature.

WIDER IMPLICATIONS OF THE FINDINGS: Women have higher knowledge of and lower interest in having the AMH test when given evidence-based information about the test and its limitations. Despite previous studies suggesting women are enthusiastic about AMH testing to learn about their fertility potential, we demonstrate that this enthusiasm does not hold when they are informed about the test's limitations.

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Introduction

The anti-Mullerian hormone (AMH) can be measured by a blood test and gives an indication of the number of oocytes in the ovaries, but not of oocyte quality (Dewailly and Laven, 2019; Hunt and Vollenhoven, 2020). Whilst the test is helpful in assisted reproduction as it roughly indicates the potential number of oocytes retrievable for *in vitro* fertilization or oocyte freezing (Broer *et al.*, 2013), the test cannot reliably predict the chance of conceiving or the age of menopause for individual women (Depmann *et al.*, 2018; Lin *et al.*, 2021; Nelson *et al.*, 2023). As such, AMH testing for women outside of fertility treatment settings is strongly discouraged (Practice Committee of the American Society for Reproductive Medicine, 2015; ACOG Committee Opinion, 2019). Despite this, the test is increasingly promoted as a way for women to find out about their fertility or reproductive timeline. Online companies in the USA, Australia, The Netherlands, and elsewhere now sell the test direct-to-consumers, falsely promising women detailed insights into their fertility potential (Johnson *et al.*, 2023). Inaccurate information about the AMH test has also been identified on other websites including accredited fertility clinic websites (Copp *et al.*, 2021).

The prevalence of misleading and false information has raised concerns that the test is being used outside of recommended settings (Copp *et al.*, 2024). Indeed, our recent cross-sectional population-level survey examining AMH test usage found that, of the Australian women aged 18–55 years who reported having had an AMH test, one-third reported reasons not supported by evidence (Copp *et al.*, 2023). For example, 19% had the test because they were considering getting pregnant soon and wanted to understand their chances of conceiving, and 9% had the test because they were curious about their fertility (Copp *et al.*, 2023). This is concerning because the test is invalid for these purposes. In addition to undermining informed choice, misleading women into believing this test can reliably predict their fertility may have serious consequences. Previous research on polycystic ovary syndrome has illustrated how anticipated infertility can influence life choices and behaviour (Copp *et al.*, 2019). For example, using the AMH test to plan pregnancy could give women a false sense of security about delaying pregnancy or unwarranted anxiety about their ability to conceive, pressuring them to try to conceive earlier than preferred or to undergo fertility treatment (O'Brien *et al.*, 2020; Copp *et al.*, 2021).

Studies in the USA, Australia, and The Netherlands have demonstrated that women are interested in ovarian reserve testing when uninformed about the test's limitations (Grootenhuys *et al.*, 2021), and may change their reproductive timeline or consider fertility preservation (e.g. oocyte freezing) if their AMH result is low (Azhar *et al.*, 2015; Evans *et al.*, 2018; Hurley *et al.*, 2018). These are high stake decisions and access to high-quality, accurate information to enable informed decision-making is therefore essential. Evidence is lacking on how information about the unreliability of the test affects women's attitudes towards the test and their decision about whether to have the test. Given the plethora of misleading, commercially driven statements about the AMH test online, this study aimed to co-design evidence-based information about the AMH test and examine its impact

on women's interest in having the test, knowledge about, and attitudes towards the test.

Materials and methods

Study design

This was an online randomized controlled trial and is reported according to the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline for randomized clinical trials (Schulz *et al.*, 2010). Participants were randomly allocated to one of two information pamphlets about the AMH test, either: (i) co-designed, evidence-based information about the AMH test, or (ii) content from an existing website promoting the test direct-to-consumers, using a balanced allocation ratio.

Ethics approval

This study was approved by the University of Sydney Human Research Ethics Committee (2022/177) and the University of Maastricht (FHML-REC/2022/060). The trial was prospectively registered in the Australian New Zealand Clinical Trials Registry (ACTRN12622001136796).

Intervention co-design and development

The intervention consisted of evidence-based information about the AMH test, including what the test does and does not measure and the potential benefits and harms of testing, including the limitations of the test (e.g. that it cannot predict chance of conceiving or timing of menopause for individual women; [Supplementary Data File S1](#)). The information was co-designed with all relevant stakeholders including seven consumers (four from Australia and three from The Netherlands) and four clinicians with different clinical backgrounds (two general practitioners (GPs) and two gynaecologists) in addition to the multidisciplinary study team with expertise in co-design, randomized controlled trials, obstetrics and gynaecology, assisted reproduction, and behavioural science. The co-design process was guided by the Agency for Clinical Innovation's principles and process (Agency for Clinical Innovation, 2023).

Explore and understand

First, we reviewed and synthesized the current evidence on the utility of the AMH test (see previous work; Copp *et al.*, 2021, 2023). Subsequently, we ran 1.5-hr long co-design workshops via Zoom with consumers in Australia and The Netherlands to gather experiences with the AMH test and impressions of the evidence, and to explore information needs.

Design and development

Based on the synthesized evidence and the consumer feedback, an information sheet was developed first in English which underwent several rounds of feedback and revision by the multidisciplinary team, consumers, and clinicians. To increase the reading ease and reduce the health literacy demands of the information, it was also revised using the Sydney Health Literacy Lab Health Literacy Editor (Ayre *et al.*, 2023). This involved minimizing the use of jargon and the passive voice, as well as reducing sentence length and complexity. The information was then translated into

Dutch and further reviewed by the Dutch consumer panel and a Dutch GP.

Pilot evaluation

After co-designing the intervention materials (Supplementary Data File S1), the study was piloted with 10 women (consumers) to test the data collection procedures and ensure the suitability of study materials and measures.

Control arm

The control information consisted of the content on an existing website selling the AMH test direct-to-consumers in Australia, formatted to visually match the intervention materials. Copies of the intervention and control materials are provided in Supplementary Data Files S1 and S2.

Participants and recruitment

Eligible participants were females aged 25–40 years living in Australia or The Netherlands who had never given birth, were not currently pregnant, would like to have a child now or in the future, had never had an AMH test, and were fluent in English or Dutch. These criteria reflect the demographic characteristics of the direct-to-consumer advertising target population for the AMH test in these two countries, which have both recently seen the emergence of online companies selling AMH tests direct-to-consumers (Johnson et al., 2023).

Participants were recruited through Dynata, an independent online social research company. Potential participants from the panel were directed by email to the study landing page where they could view the participant information statement in their own language (English or Dutch) and were required to indicate their informed consent before proceeding to the screening questions, the intervention or control information, and the questionnaire. Dynata panel participants receive modest compensation for their time in the form of points (equating to ~\$3–6 AUD). These points can later be redeemed for gift vouchers or donated to charities once several surveys have been completed and a certain number of points have been accrued.

Procedure

The questionnaire was administered using Qualtrics survey software, individually for each country. After completing the eligibility screening questions, participants were randomized to either the evidence-based information or the control information. Randomization was performed by the survey platform Qualtrics, which uses the Mersenne Twister pseudorandom number generator to create allocation sequences. Participants and the research team were blinded to the group allocation at the time of the randomization. After viewing the allocated information, participants completed several outcome measures. Finally, participants answered relevant health and sociodemographic questions. To minimize non-response on outcome measures, all questions were mandatory except the sociodemographic questions and free-text responses. After completing the questionnaire, participants randomized to the control group were shown a debrief statement which included the evidence-based information from the intervention materials.

Outcomes

Outcomes were assessed using several previously validated and adapted scales (see Table 1), as well as new measures (multiple choice, Likert scales, and open-ended responses) informed by the published literature and developed by the multidisciplinary study team. The primary outcome was interest in having an

AMH test. Secondary outcomes included intention to discuss the AMH test with their doctor (Dolan et al., 2022), intention to get the test (Pickles et al., 2020), attitudes (Scherer et al., 2019), knowledge (Slater et al., 2022), emotional response to the information (Petrova et al., 2023), worry (Dolan et al., 2022), anticipated psychological reaction to having an AMH test (Vakkas et al., 2023), anticipated impact on family planning (Evans et al., 2018), and information satisfaction. Sociodemographic and health characteristics included age, relationship status, whether currently trying to conceive, perceived importance of having children ('How important is it to you to have children one day?' [1 = not important at all to 5 = very important]) (Prior et al., 2019), history of infertility, chronic conditions, family history of premature menopause, location, main language spoken at home, education, health literacy (the single-item health literacy screener; Chew et al., 2004), preference for more or less healthcare (the single item Medical Maximizer-Minimizer scale; Scherer and Zikmund-Fisher, 2020), and private health insurance status.

Statistical analysis

Sample size

Based on the piloting of the survey materials, a total sample size of $N = 800$ ($n = 400$ participants per country, with equal allocation to the intervention or control group) was calculated to provide more than 90% power to detect the effect of the intervention on interest in getting an AMH test ($0.24SDs = 0.4$ units on a seven-point scale) at an alpha level of 0.01. This would also provide more than 80% power to detect a country by intervention interaction no smaller than 0.75 times the effect of the intervention alone. We intentionally over-sampled by 25% in each group ($n = 500$ per country, with $n = 250$ randomized to each arm within each country) to account for the possibility of smaller effect sizes, or removal due to data cleaning as described below.

Analyses

Statistical analysis was conducted in Stata/IC v17 (StataCorp). The data were first cleaned and checked for missing values, outliers, and invalid responders (failed attention check or repeat participants evidenced by identical responses, including free text). Baseline and demographic characteristics were then quantified, with the mean and SDs calculated for continuous variables, and frequencies and relative frequencies for categorical variables. Overall differences between randomized arms were analysed using linear, Poisson, logistic, and ordinal logistic regression models (except for impact on family planning which was examined using chi-square tests). Results are presented for main effects of information (effect of the study factor averaged across country). Country (Australia, The Netherlands) was also included as a categorical covariate for the primary outcome to examine for main effects as well as the interaction between country and information.

An inductive content analysis was conducted for the open-ended question 'What do you think is the take-home message of the information you read about the AMH test?' to extract patterns and/or themes, with the frequency of each identified theme calculated (Hsieh and Shannon, 2005). First, three researchers (T.C., L.A., F.V.M.) reviewed the free-text responses and each developed an initial list of recurring codes. These lists were then discussed and combined to create a coding framework. All free-text responses were then coded into the framework. To ensure consistency and rigour, 30% of free-text responses were double coded by two researchers independently (T.C. and L.A.). The level of agreement between the two researchers was tested using Cohen's kappa and indicated a strong level of agreement ($k = 0.757$) (McHugh,

Table 1. Outcome measures.

Measure and reference	Items	Scale/responses and coding instructions
Interest in getting an AMH test	Now that you have read the information, are you interested in getting an AMH test?	Seven-point scale (1 = definitely NOT interested to 7 = definitely interested)
Intention to discuss the AMH test with doctor ¹	After reading this information, would you talk to your doctor about getting an AMH test?	a) Yes b) No c) Don't know
Intention ²	Which of the following best describes your intentions to get an AMH test?	Five-point scale (1 = I definitely will NOT get a AMH test to 5 = I definitely will get a AMH test)
Attitudes ³	<ol style="list-style-type: none"> How beneficial does an AMH test seem to you? How harmful does getting an AMH test seem to you? [R] Do you believe that getting an AMH test will give you important information about your fertility? Do you believe that getting an AMH test will give you reliable information about your fertility? 	Seven-point scale (1 = not at all to 7 = extremely) Items averaged to create composite score.
Knowledge ⁴	<p>Please indicate whether you think the statements below about the AMH test are true or false</p> <ol style="list-style-type: none"> The AMH level is an indication of the number of eggs in the ovaries (T) The AMH level is an indication of the quality of the eggs in the ovaries (F) The AMH test can reliably predict fertility (likelihood of conceiving) (F) The AMH test can reliably predict age of menopause (F) Oral contraception use does not affect AMH results (F) 	a) True b) False c) Don't know Responses dichotomized into 0 = incorrect or 1 = correct, then summed to create total knowledge score (range 0–5).
The Berlin Emotional Responses to Risk Instrument ⁵	<p>How did you feel when you read the information about the AMH test?</p> <ol style="list-style-type: none"> Assured Hopeful Relieved Anxious Afraid Worried 	Seven-point scale (1 = not at all to 7 = extremely) Items 1–3 averaged to create composite score of positive responses; Items 4–6 averaged to create composite score of negative responses.
Worry about fertility ¹	How worried are you about your chance of getting pregnant?	a) Not worried at all b) A bit worried c) Quite worried d) Very worried
Anticipated psychological reaction of getting an AMH test ⁶	<p>Getting an AMH test would make me feel:</p> <ol style="list-style-type: none"> Empowered Anxious [R] Worried [R] Reassured More in control Pressured, urgency to act [R] Better prepared Confused about what to do [R] 	Five-point scale (1 = strongly disagree to 5 = strongly agree) Items averaged to create composite score.
Anticipated impact on family planning ⁷	<ol style="list-style-type: none"> Do you think getting a low AMH result (indicating you are likely to have a lower number of eggs) would influence your decision on when to start a family? (if yes) how would it influence your decision on when to start a family? Do you think getting a normal or high AMH result (indicating you are likely to have a normal or high number of eggs) would influence your decision on when to start a family? (if yes) how would it influence your decision on when to start a family? 	a) Yes b) No c) Unsure Dichotomized into 'yes' vs 'unsure'/'no'. (If yes) a) I would bring forward plans to start a family/try and conceive b) I would push back plans to start a family/try and conceive c) I would reconsider my decision to start a family/try and conceive d) I would consider elective egg freezing e) Other (please specify)
Information satisfaction	<p>Please indicate how you felt about the AMH information on the five-point scale:</p> <p>The information was ...</p> <ol style="list-style-type: none"> Comprehensive Trustworthy 	Five-point scale (1 = strongly disagree to 5 = strongly agree)

(continued)

Table 1. Continued

Measure and reference	Items	Scale/responses and coding instructions
	3. Balanced	
	4. Clear and easy to understand	

[R], reverse scored; (T), true; (F), false.

¹ Adapted from Dolan et al., *JAMA Network Open* 2022; 5: e2216784.

² Adapted from Pickles et al., *PLoS One* 2020; 15: e0227304.

³ Adapted from Scherer et al., *Journal of Experimental Psychology: Applied* 2019; 25: 149.

⁴ Adapted from Slater et al., *Australian Journal of General Practice* 2022; 51: 611–619.

⁵ Petrova et al., *Risk Analysis* 2023; 43: 724–746.

⁶ Adapted from Vakkas et al., ASPOG2023, Adelaide, Australia.

⁷ Adapted from Evans et al., *Aust J Prim Health* 2018; 24: 428–433.

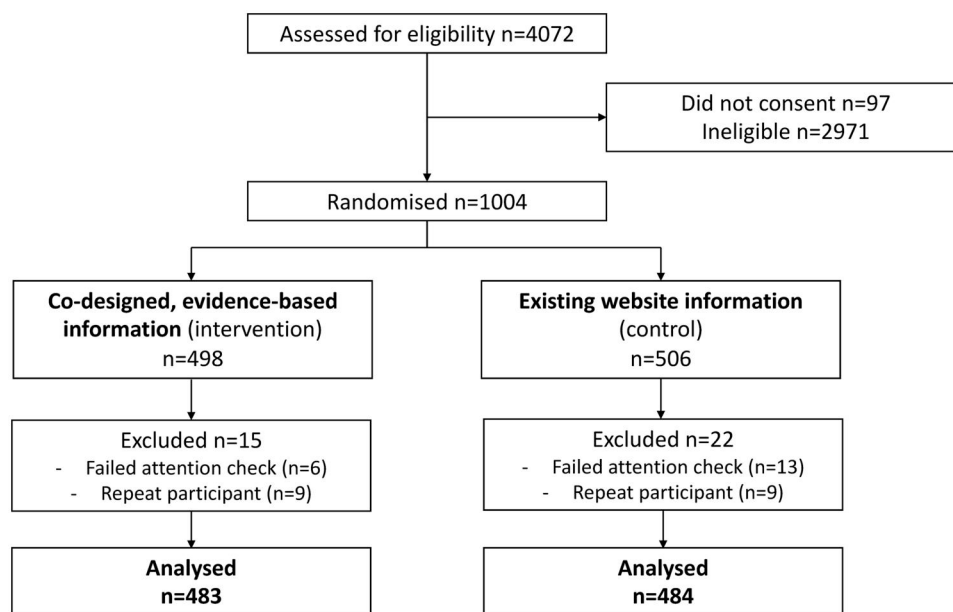


Figure 1. Participant flow diagram.

2012). Descriptive statistical analysis was then used to calculate the frequency of each code, with quotes selected to illustrate findings.

Results

Of the 1004 eligible participants who were randomized, 37 were excluded due to failing the attention check question or repeat participation. This left a total of 967 participants for the final analysis (intervention $n = 483$, control $n = 484$, see Fig. 1).

Sociodemographic and health characteristics

The sample characteristics by randomized group are reported in Table 2. Overall, 70% of participants were in a relationship, 7% reported a family history of premature menopause, 11% had previously heard about the AMH test, and 16% had experienced infertility. Almost all (95%) of participants spoke English or Dutch as their main language at home, 46% had a bachelor's degree or higher and 80% had adequate health literacy according to the health literacy screener (Chew et al., 2004).

Main outcome

Interest in getting an AMH test (1 = definitely not interested to 7 = definitely interested)

Women who received the evidence-based information (intervention) had less interest in getting an AMH test (mean (M)=3.87,

95% CI = 3.71–4.03) than women who viewed the existing website information (control; $M = 4.93$, 95% CI = 4.77–5.09; mean difference (MD) = 1.05, $P < 0.001$, 95% CI = 0.83–1.30; Table 3).

There was also a main effect of country, with women living in Australia having higher interest in having an AMH test than those living in The Netherlands, irrespective of information viewed (MD = 0.36, $P = 0.027$, 95% CI = 0.04–0.68).

Secondary outcomes

Discuss with doctor (yes/no/don't know)

When asked if participants would talk to their doctor about getting an AMH test, 174 (36%) in the intervention and 254 (53%) in the control group indicated 'yes' ($P < 0.001$).

Intention to get an AMH test (1 = I definitely will NOT get an AMH test to 5 = I definitely will get an AMH test)

Intention to get an AMH test was statistically lower for those who viewed the evidence-based information ($M = 2.84$, 95% CI = 2.75–2.93) than those who viewed the control information ($M = 3.36$, 95% CI = 3.27–3.45; MD = 0.52, $P < 0.001$, 95% CI = 0.39–0.65).

Attitudes towards the test (1 = not at all to 7 = extremely)

Women who viewed the evidence-based information had less-positive attitudes towards the test ($M = 3.96$, 95% CI = 3.86–4.06) than women who viewed the control information ($M = 5.25$, 95%

Table 2. Characteristics of analysis sample (N = 967).

Variable	Evidence-based information (intervention; n = 483)	Existing website information (control; n = 484)
	Mean (SD)	Mean (SD)
Age (years)	30.6 (4.18)	30.3 (4.06)
	n (%)	n (%)
Country of residence		
Australia	230 (48)	230 (48)
Netherlands	253 (52)	254 (52)
Relationship status		
In a relationship (opposite sex)	322 (67)	309 (64)
In a relationship (same sex)	16 (3)	24 (5)
Not in a relationship	142 (30)	146 (30)
[missing]	3 (1)	5 (1)
Currently trying to conceive		
No	371 (77)	369 (77)
Yes	109 (23)	111 (23)
[missing]	3 (1)	4 (1)
Importance of having children		
Not important at all	10 (2)	6 (1)
Not very important	34 (7)	28 (6)
Neutral	109 (23)	119 (25)
Important	183 (38)	179 (37)
Very important	144 (30)	148 (31)
[missing]	3 (1)	4 (1)
Experience of infertility		
Yes	72 (15)	77 (16)
No	399 (83)	395 (82)
Don't know	9 (2)	8 (2)
[missing]	3 (1)	4 (1)
Chronic conditions ^a		
Polycystic ovary syndrome	56 (12)	40 (8)
Endometriosis	24 (5)	22 (5)
Thyroid disease	32 (7)	25 (5)
An autoimmune disease	22 (5)	24 (5)
Cancer	5 (1)	5 (1)
Primary ovarian insufficiency	1 (0)	1 (0)
Other	9 (2)	12 (2)
Family history of premature menopause		
Yes	39 (8)	31 (6)
No	369 (76)	377 (78)
Don't know	71 (15)	71 (15)
[missing]	4 (1)	5 (1)
Medical minimizer maximizer preference		
Lean towards waiting and seeing	244 (51)	250 (52)
Lean towards taking action	230 (48)	225 (47)
[missing]	9 (2)	9 (2)
Residential location remoteness		
Urban	269 (56)	272 (56)
Regional	131 (27)	122 (25)
Rural	53 (11)	59 (12)
Remote	3 (1)	1 (0)
[missing]	27 (6)	30 (6)
Main language spoken at home		
English/Dutch	450 (93)	442 (91)
Other	24 (5)	27 (6)
[missing]	9 (2)	15 (3)
Education		
High school or below	96 (20)	105 (22)
Diploma or certificate	146 (30)	163 (34)
Bachelor degree or above	227 (47)	201 (42)
[missing]	14 (3)	15 (3)
Health literacy screener		
Low ('inadequate') health literacy	105 (22)	86 (18)
Adequate health literacy	375 (78)	392 (81)
[missing]	3 (1)	6 (1)
Private health insurance		
Yes	358 (74)	358 (74)
No	118 (24)	120 (25)
[missing]	7 (1)	6 (1)
Prior knowledge of the AMH test		
Yes	52 (11)	52 (11)
No	414 (86)	408 (84)
Don't know	14 (3)	21 (4)
[missing]	3 (1)	3 (1)

^a Chronic conditions were not mutually exclusive.

Table 3. Summary statistics of outcome measures, by randomized group.

Outcome measure	Evidence-based information (intervention; n = 483)	Existing website information (control; n = 484)	P-value
	Mean (95% CI)	Mean (95% CI)	
Interest in getting an AMH test	3.87 (3.71–4.03)	4.93 (4.77–5.09)	<0.001
Intention to get an AMH test	2.84 (2.75–2.93)	3.36 (3.27–3.45)	<0.001
Attitudes towards the AMH test	3.96 (3.86–4.06)	5.25 (5.15–5.35)	<0.001
Knowledge about the AMH test	3.14 (2.98–3.30)	2.39 (2.26–2.53)	<0.001
Positive emotional reactions to information presented	3.91 (3.79–4.03)	4.70 (4.58–4.83)	<0.001
Negative emotional reactions to information presented	3.47 (3.33–3.62)	3.34 (3.20–3.48)	0.193
Worry about chances getting pregnant	2.21 (2.13–2.28)	2.14 (2.07–2.22)	0.248
Anticipated psychological reaction of having an AMH test	2.98 (2.92–3.03)	3.34 (3.29–3.40)	0.001
Information satisfaction	3.94 (3.88–4.00)	3.96 (3.90–4.02)	0.605
	n (%)	n (%)	P-value
Discuss with doctor—indicated ‘Yes’	174 (36%)	254 (53%)	<0.001
Impact on family planning intentions—indicated ‘Yes’	211 (44%)	253 (52%)	0.008

CI = 5.15–5.35; MD = 1.29, $P < 0.001$, 95% CI = 4.57–5.70). See Table 4 for mean scores on the individual attitude items.

Knowledge about the AMH test (true/false/don’t know)

For the knowledge items assessing information that was absent in the information viewed by the control group (items 2–4 regarding egg quality, fertility, and menopause), knowledge scores were consistently higher for those shown the evidence-based information (see Table 4). Overall total knowledge was also significantly higher in women who viewed the evidence-based information ($M = 3.14$, 95% CI = 2.98–3.30) compared to women who viewed the control information ($M = 2.39$, 95% CI = 2.26–2.53; MD = 0.75, $P \leq 0.001$, 95% CI = 0.71–0.82).

Emotional reaction to the information presented (1 = not at all to 7 = extremely)

When participants were asked how they felt when they read the information about the AMH test, women in the control group reported more positive emotional reactions (i.e. assured, hopeful, relieved; $M = 4.70$, 95% CI = 4.58–4.83) compared to women who viewed the evidence-based information ($M = 3.91$, 95% CI = 3.79–4.03; MD = 0.80, $P < 0.001$, 95% CI = 0.62–0.97). However, there were no differences between groups in terms of negative reactions (i.e. anxious, afraid, worried; MD = 0.13, $P = 0.193$, 95% CI = –0.34 to 0.07).

Similarly, there were no differences between groups regarding participants’ worry about their chances of getting pregnant (MD = 0.06, $P = 0.248$, 95% CI = –0.17 to 0.04).

Anticipated psychological reaction of having an AMH test (1 = strongly disagree to 5 = strongly agree; higher scores = more positive anticipated reaction)

When asked how having an AMH test would make them feel, women randomized to the control information anticipated more positive emotions (e.g. more empowered, less anxious, etc) ($M = 3.34$, 95% CI = 3.29–3.40) than those who viewed the evidence-based information ($M = 2.98$, 95% CI = 2.92–3.03; MD = 0.37, $P = 0.001$, 95% CI = 0.29–0.45).

Impact on family planning intentions (yes/no/unsure)

When asked whether getting a low AMH result would influence their decision on when to start a family, those in the control group were more likely to indicate yes (52%, $n = 253$) than those in the intervention group (44% $n = 211$; $P = 0.008$).

For those who indicated ‘yes’, the top action selected for both groups was that they would bring forward their plans to conceive (see Table 4 for frequencies of all anticipated actions).

When asked if getting a normal or high AMH result would influence the decision on when to start a family, women who viewed the evidence-based information ($n = 153$ indicated ‘yes’; 32%) did not differ from those who viewed the control information ($n = 160$ indicated ‘yes’; 33%; $P = 0.646$).

Information satisfaction (1 = strongly disagree to 5 = strongly agree)

The mean total information satisfaction score was relatively high for both the evidence-based information ($M = 3.94$, SD = 0.72) and the control information ($M = 3.96$, SD = 0.65), with no statistical difference between groups ($P = 0.605$, 95% CI = –0.06 to 0.11) (Table 3).

Respondents’ interpretation of the take-home message of the information

When participants were asked what they thought was the take-home message of the information they read (free-text answer), the top three codes from the content analysis for women shown the evidence-based information were that (i) the AMH test was not reliable or helpful (34%, e.g. ‘That it’s not the crystal ball people make it out to be’), (ii) it provides information about quantity of eggs (8%), or (iii) it was only useful when having difficulty conceiving or undergoing fertility treatment (6%; see Table 5 for all codes and illustrative quotes).

The top three codes for the control group were that (i) it provides information about chances of pregnancy (24%, e.g. ‘AMH testing can predict your chances of pregnancy’), (ii) it provides information about quantity of eggs (13%), or (iii) it was important to take the test (7%; see Table 5).

Discussion

Main findings

When supported with co-designed and evidence-based information about the AMH test, women have lower interest in having the test, lower intention to discuss the test with their doctor, less positive attitudes towards the test, and higher knowledge about the test than when commercial advertising of the AMH test is their source of information. Whilst women who viewed the evidence-based information reported less positive emotional reactions to the information (less assured, hopeful, relieved), an

Table 4. Summary statistics for individual items for attitudes, knowledge, and anticipated actions regarding family planning, by randomized group.

	Intervention Mean (SD)	Control Mean (SD)
Attitude items (seven-point scale, higher scores=more positive attitudes)		
How beneficial does an AMH test seem to you?	3.96 (1.79)	5.28 (1.31)
How harmful does an AMH test seem to you? [R]	5.01 (1.51)	5.32 (1.46)
Do you believe that getting an AMH test will give you reliable information about your fertility?	3.32 (1.74)	5.04 (1.23)
Do you believe that getting an AMH test will give you important information about your fertility?	3.55 (1.75)	5.26 (1.25)
Knowledge items (Response options: True/false/don't know)		
	Intervention n (%) correct	Control n (%) correct
1. The AMH level is an indication of the number of eggs in the ovaries (T)	345 (71)	381 (79)
2. The AMH level is an indication of the quality of the eggs in the ovaries (F)	300 (62)	225 (46)
3. The AMH test can reliably predict fertility (likelihood of conceiving) (F)	303 (63)	95 (20)
4. The AMH test can reliably predict age of menopause (F)	330 (68)	177 (37)
5. Oral contraception use does not affect AMH results (F)	240 (50)	281 (58)
Anticipated actions for those who indicated 'yes' to an AMH result influencing their decision on when to start a family		
	Intervention n (%)	Control n (%)
Anticipated action if AMH result was low		
I would bring forward plans to start a family/try and conceive	124 (59%)	163 (64%)
I would push back plans to start a family/try and conceive	19 (9%)	21 (8%)
I would reconsider my decision to start a family/try and conceive	39 (18%)	32 (13%)
I would consider elective egg freezing	26 (12%)	36 (14%)
Other (please specify)	3 (1%)	1 (0.5%)
Anticipated action if AMH result was normal or high		
I would bring forward plans to start a family/try and conceive	63 (41%)	68 (43%)
I would push back plans to start a family/try and conceive	55 (36%)	45 (28%)
I would reconsider my decision to start a family/try and conceive	25 (16%)	28 (18%)
I would consider elective egg freezing	8 (5%)	14 (9%)
Other (please specify)	2 (1%)	5 (3%)

[R], reverse scored; (T), true; (F), false.

expected response to the evidence-base, there were no differences in terms of negative reactions (anxious, afraid, worried).

Comparison with existing literature

These results support findings from previous studies that show a high interest in AMH testing when women are uninformed about the test's limitations (Azhar et al., 2015; Evans et al., 2018; Hurley et al., 2018; Grootenhuis et al., 2021). Although the mean score for those shown the evidence-based information was under the midpoint on the scale, indicating these women were not interested in AMH testing on average, a substantial proportion of this group was still interested despite being informed of the test's limitations. This general enthusiasm for medical tests and information may in part be explained by the ingrained cultural and societal beliefs that 'information is power' and 'more is better', which are recognized as drivers of overdiagnosis and medical overuse (Pathirana et al., 2017). Interestingly, interest in testing was higher in Australian participants, which may reflect higher endorsement of these cultural beliefs than in the Netherlands. An interview study of experts on low-value care highlighted how, in the Netherlands, clinicians are less inclined to provide unnecessary care and patients are more accepting of the idea that testing is not always positive, perhaps due to the lower risk of litigation and their more Calvinistic attitudes compared to other countries (Verkerk et al., 2022). Overall, the findings from the current study indicate that when women are provided with the evidence and informed of the test's limitations, they are less interested in having an AMH test. This is likely a reflection of the higher knowledge and less positive attitudes towards the test, suggesting that the women who viewed the evidence-based information had a more realistic view about what the test can and cannot do.

Interestingly, there were no differences between groups in terms of attitudes about whether an AMH test could be harmful,

despite the intervention materials listing the potential downstream harms of inappropriate testing (i.e. false sense of security, needless worry, and pressure to conceive or undergo unnecessary procedures). This finding aligns with other research on low-value care which shows that people find potential downstream harms of medical overuse difficult to conceptualize (Brownlee and Korenstein, 2021), such as changing family planning behaviour based off an inaccurate test, psychological distress, and other downstream consequences (Korenstein et al., 2021). In the case of a simple blood test, it may be reasonable to presume that it does not cause harm, particularly as possible downstream harms can occur long after an inappropriate test, and may be difficult to trace back to the test itself (Brownlee and Korenstein, 2021). Further, the tendency of people to overestimate the benefits and underestimate the harms of medical interventions has been demonstrated in various medical contexts (Hoffmann and Del Mar, 2015). For example, female infertility patients were equally as willing to use a new hypothetical fertility treatment to improve a proxy or secondary IVF outcome (e.g. fertilization or implantation rate but not live birth rate) whether or not they were told that it may pose risk to themselves/their resulting pregnancy (Carrick et al., 2023).

Concerningly, information satisfaction was high in the control group, suggesting women considered the misleading information trustworthy and balanced. Given the prevalence of misleading information about the AMH test identified online (Copp et al., 2021; Johnson et al., 2023) and the potential harms of inappropriate AMH test use, women urgently need better access to evidence-based information about the AMH test. The information developed as part of this study may be useful for clinicians as well as online service providers in delivering unbiased, factual information to help women make an informed decision about whether to have the AMH test, as well as increase awareness of the test's limitations. This will likely reduce inappropriate use of

Table 5. Content analysis results for free-text question ‘What do you think is the take-home message of the information you read about the AMH test?’ by randomized group.

Results for those randomized to the evidence-based information group (N = 483)		
Code	Example quote	n (%)
Can't tell you anything about fertility or quality of eggs, is unreliable, not helpful, or inaccurate	'AMH is not an accurate test to determine anything in terms of pregnancy chances and eggs quality'	165 (34%)
Not specific/unclear	'To use as a guideline'	44 (9%)
Can provide information about quantity of eggs	'The test is available for those who want to know that amount of eggs they have. It's an option'	39 (8%)
Only useful when having difficulties conceiving or if the doctor thinks it's necessary	'It's a good test for doctors to interpret for IVF and egg freezing procedures. The average person shouldn't feel the need to take one unless undergoing the following procedures.'	29 (6%)
Can provide information about fertility (i.e. chances to get pregnant)	'It is handy to consider doing the test if you want an idea about what your chances are with having a child'	26 (5%)
The test exists	'There's a test if you want to find out'	23 (5%)
Other	'I haven't heard of it, because I've never had it done'	22 (5%)
It's important to take the test/worth getting	'AMH testing is important for women of childbearing age.'	19 (4%)
Don't know/unsure	'I'm not sure.'	17 (4%)
Test could increase chances of pregnancy or can improve pregnancy	'It helps with pregnancy'	10 (2%)
People are being misinformed about the test/ women need better information	'That people are misinformed and there needs to be more information shared about it.'	9 (2%)
Can provide information about egg quality	'AMH will help women understand the amount and quality of their eggs however does not measure fertility and may not work for those with PCOS or taking the pill'	8 (2%)
Helpful for decision-making re family planning/ when to get pregnant	'Get tested if you are older, helps with planning a family'	8 (2%)
Empowerment language, e.g. Be in control, be better informed, be more aware of your fertility	'Take control of fertility'	8 (2%)
Can give false sense of security, hope, stress, or pressure	'Be in control'	8 (2%)
I will get it when I'm older/when I'm trying to get pregnant	'It could give women a false sense of security or cause stress or pressure to fall pregnant'	8 (2%)
The only way to test your fertility is to try conceiv- ing/there is no test of fertility	'When I'm a bit older I may get one'	4 (0.8%)
I want more information	'Women shouldn't rely on AMH tests when deciding on whether to start a family or not as they can't predict quality of eggs. They can offer some insight for people doing IVF. The only way to get an accurate understanding of fertility is to try to conceive'	4 (0.8%)
Inform reproductive timeline/menopause timing	'I want to get more information on it'	4 (0.8%)
Good for peace of mind	'This test provides insight into my fertility and detects the onset of menopause.'	3 (0.6%)
Is not useful when using the pill	'That it is an option for women that need more reassurance about their fertility.'	3 (0.6%)
Is expensive/costly	'That it is for indicating number of eggs in ovaries and not at all a measure of fertility. Furthermore, the results can be affected by oral contraceptives and PCOS'	3 (0.6%)
	'don't waste time or money'	2 (0.4%)
Results for those randomized to the control group (N = 484)		
Code	Example quote	n (%)
Can provide information about fertility (i.e. chances to get pregnant)	'It will give you more information about your fertility and let you plan next steps'	116 (24%)
Can provide information about quantity of eggs	'AMH testing can predict your chances of pregnancy'	64 (13%)
Not specific/unclear	'AMH test tells you how many eggs you have left'	42 (9%)
It's important to take the test/worth getting	'The AMH test provides a clear analysis of a woman's egg count and is also used in fertility treatments'	36 (7%)
The test exists	'that if you're unsure there is a test to find out'	34 (7%)
Empowerment language, e.g. Be in control, be better informed, be more aware of your fertility	'AMH is very important for women of childbearing age to test their own fertility.'	31 (6%)
Helpful for decision-making re family planning/ when to get pregnant	'To be aware that the test exists and it's an option'	26 (5%)
Inform reproductive timeline/menopause timing	'Ability to check if you wish to do so, empowerment to take control of your health a bit more'	24 (5%)
Don't know/unsure	'If you are planning to have a family and to curious about your fertility, getting AMH test might be able to help you decide.'	18 (4%)
	Helpful for women planning to push back conceiving date'	
	'This is a medical, reliable way to predict fertility. It can assist in decision making regarding timing of starting a family and may indicate beginnings of menopause.'	24 (5%)
	'I'm not sure'	18 (4%)

(continued)

Table 5. Continued

Results for those randomized to the control group (N = 484)

Code	Example quote	n (%)
Good for peace of mind	'To give women peace of mind'	15 (3%)
Other	'It should be advertised more'	14 (3%)
The test is easy and inexpensive	'There is an easy and relatively inexpensive way to check fertility'	10 (2%)
I will ask my doctor for this test/I should get this test	'That it's probably time I look at organising to get a test done'	9 (2%)
Can provide information about quality of eggs	'It is a test to see how fertile and the quality of a woman's eggs can be.'	7 (1%)
I will get it when I'm older/when I'm trying to get pregnant	'If your older like myself take the test so you can make informed decisions about starting a family'	7 (1%)
Can't tell you anything about fertility or quality of eggs, is unreliable, not helpful, or inaccurate	'an indicator, not 100%'	7 (1%)
Test could increase chances of pregnancy or can improve pregnancy	'That is a worthwhile tool to assist women in their pregnancy journeys'	7 (1%)
The test is safe/not invasive	'It's a really easy, non-invasive way to find out your chances of fertility'	6 (1%)
Can provide information about a fertility, e.g. PCOS or highlight a potential issue	'That having the AMH test can give you reliable information about your fertility, like how many eggs you have left, and also information about possible conditions like PCOS.'	5 (1%)
I want more information	'Would like to find out more'	5 (1%)
Only useful when having difficulties conceiving or if the doctor thinks it's necessary	'The AMH test provides a clear analysis of a woman's egg count and is also used in fertility treatments'	4 (0.8%)

the AMH test, as well as any unfounded actions taken in response to the test result.

Strengths and limitations

To our knowledge, this is the first study to co-design and test the efficacy of evidence-based information about AMH test. Other strengths include the randomized design which enabled us to robustly assess the evidence-based information against a typical direct-to-consumer information source accessed by women, and that the trial was conducted among reproductive-aged women who have not yet had children, the target audience of oocyte freezing and AMH test advertising. A limitation of the study is that it was conducted in an online panel sample. It is not possible to know how much participants engaged with the information presented, although minimum time requirements were placed on the intervention and control information pages before participants were able to proceed to the questionnaire to increase the likelihood of them reading the information presented. The sample was also more highly educated than the broader Australian and Dutch populations, and some measures (e.g. influence on family planning) were hypothetical in nature.

Conclusion

When enabled to make an informed decision through the provision of evidence-based information, women have lower interest in having an AMH test, and less positive attitudes towards and higher knowledge of the AMH test. This study has produced crucial, evidence-based information for consumers, which, if adopted, will likely reduce inappropriate use of the AMH test.

Supplementary data

Supplementary data are available at *Human Reproduction* online.

Data availability

Data are available on reasonable request.

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Authors' roles

T.C., K.M., and J.J. conceived the study. T.C., T.v.N., E.C., K.J.M., K.H., J.D., S.L., M.P., B.W.M., D.L., and J.J. were involved in designing the study and developing the methods. T.C. and T.v.N. conducted the consumer workshops. T.C. conducted the statistical analyses with input from E.C. T.C., L.A., and F.v.d.M. conducted the content analyses. T.C. drafted the manuscript. All authors critically revised and approved the manuscript.

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Conflict of interest

B.W.M. reports consultancy for ObsEva and Merck and travel support from Merck. D.L. is the Medical Director of, and holds stock in, City Fertility NSW and reports consultancy for Organon and honoraria from Ferring, Besins, and Merck. K.H. reports consultancy and travel support from Merck and Organon. K.M. is a director of Health Literacy Solutions that owns a licence of the Sydney Health Literacy Lab Health Literacy Editor. No other relevant disclosures exist.

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