

The Use of a Game-Based Decision Aid to Educate Pregnant Women about Prenatal Screening: A Randomized Controlled Study

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Abstract

Purpose This project developed and evaluated the efficacy of a game decision aid among pregnant women about prenatal screening in a randomized controlled study. **Study Design** Participants were recruited from an obstetric clinic of an academic urban medical center and randomized ($n = 73$) to one of two study groups: the control group ($n = 39$) that used a brochure or the intervention group ($n = 34$) that also used a game decision aid.

Result Participants who played the game had higher knowledge scores ($m = 21.41$, standard deviation [SD] = 1.74) than participants in the control group ($m = 19.59$; SD = 3.31), $p = 0.004$. The median time of game playing was 6:43 minutes (range: 2:17–16:44). The groups were similar in frequency of completing screening after the study, control = 6 (15%) versus intervention = 11 (32%), $p = 0.087$. However, the more interaction with the game resulted in more positive attitudes toward screening.

Conclusion The addition of a game decision aid was effective in educating pregnant women about prenatal screening. As other genetic testing decisions continue to increase within clinical care, game-based decision tools may be a constructive method of informed decision-making.

Keywords

- ▶ prenatal screening
- ▶ decision aid
- ▶ games
- ▶ randomized controlled study
- ▶ education

The American College of Obstetricians and Gynecologists (ACOG) recommends that prenatal care providers offer all women prenatal screening in the first trimester of pregnancy, regardless of age or genetic risk status.¹ This has moved the focus of prenatal screening from a subset of higher risk women to all pregnant women. However, significant barriers remain for effectively informing women about the risks and options for identifying and managing chromosomal anomalies and heritable conditions during pregnancy. It is widely recognized that current standards for patient educa-

tion in this domain are largely ineffective.^{2–4} This is due to several factors, including limited appointment time by clinicians, the routinization of prenatal screening, lack of effective education interventions, and the continued expansion of testing content and options. Decisions about prenatal screening are based on pregnant women' values and knowledge and therefore clinicians are often challenged with being informative but nondirective. As such, new and innovative methods of promoting informed decision-making about prenatal screening among patients are needed.

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One approach for informing pregnant women about their options and outcomes of prenatal screening is the use of decision aids.^{5,6} Decision aids have been used in several medical contexts in which the treatment choices are equivalent in their benefits (e.g., survival) but have differing risks. Decision aids inform patients of their options, help clarify patient values, support patients' decision process, and enable patients to engage more actively in shared decision-making with their providers.⁷ They are important in helping patients make decisions about available options that involve trade-offs in terms of outcomes and knowledge during pregnancy.

Most decision aids still use brochures or didactic presentations and do not include interactivity throughout the educational experience. Clinicians need innovative methods to educate patients. As such, interactive games have a long-standing history as effective interventions for learning and motivating health behavior.⁸ This is because contrary to information on paper or through other applications delivered on mobile devices or computers, games are generally not a one-time dissemination of information. The interactive component can provide large amounts of didactic content through unlimited opportunities to rehearse and personalize feedback associated with a game. Furthermore, players can choose various simulated roles and choices to explore different decisions on their own time even when the choices explored are value-laden and morally significant as may be the case in the context of prenatal screening.^{9,10} Also, games can increase personalization and relevance of an experience by providing a range of outcomes for players to experience, thus making them ideal for real-life health care decisions.¹¹⁻¹³ These features can significantly increase users' attention and retention of knowledge compared with a brochure or pamphlet.

However, the nondirective nature of prenatal screening education poses significant challenges for the game context. Games are often engaging through the provision of rewards to the gamer for success in working through barriers and problems toward an ultimate goal. In the health care domain, games can use such reward strategies to promote knowledge and adherence to professional recommendations. In the context of prenatal screening, the goal is not to either promote or inhibit prenatal screening per se, rather they can also be used to promote informed decision-making, present multiple options in a nondirective manner, clarify internal values, and promote communication with providers. This makes them ideal for supporting patients facing complex decisions for which the "correct" answer comes from a deeply personal decision-making process. Specifically, these issues are important when making choices about noninvasive prenatal screening. As such, the purpose of this research was to develop and evaluate the efficacy of a game decision aid on knowledge and satisfaction about noninvasive prenatal screening among pregnant women through a randomized controlled study.

Materials and Methods

The goal of this research was to develop and evaluate the efficacy of a game decision aid intervention among pregnant

women about knowledge on prenatal screening and satisfaction with this type of decision aid. The project received Institutional Review Board approval from the University of Utah (00080529).

Participants

Pregnant women were recruited from an obstetric (OB) clinic of an academic urban medical center in the intermountain west. Eligibility criteria included being English speaking, and less than 15 weeks' gestation and attending first OB visit for a low-risk pregnancy.

Procedures

Potentially eligible participants were approached immediately before their first prenatal OB visit in the clinic waiting room. If they were interested in participating, eligible participants were asked to arrive 30 minutes prior to their second OB visit. Consistent with current guidelines,¹ the official policy at the recruitment site was to offer all women prenatal screening regardless of age, family history, or other risk factors. Participants in both groups were given the brochure-based decision aid during their first OB visit in the clinic as part of routine care along with any physician communication, as per the practice of the individual clinician.

Prior to randomization, all participants provided written informed consent. Participants were then assigned based on the computer-generated simple randomization sequence to the usual care or game intervention group. Upon completion of the study, participants received a gift card. In the usual care group, participants were given the same brochure as in the clinic to remind them of content. Participants were welcomed to review the brochure as long as they liked before completing the surveys. After reviewing the brochure, participants completed the surveys.

The game intervention group was given the same brochure and instructions as the control group, but they were also asked to play for however long they wanted the game called "The Meaning of Screening." Participants then completed surveys after playing the game.

Development of the Experimental Game Intervention

The brochure-based decision aid used in the clinic is based on ACOG guidelines. Using the same content of the brochure, the game, "The Meaning of Screening," was created in collaboration with the Entertainment, Arts, and Engineering program at the University of Utah. Initial focus groups ($n = 3$) with 22 pregnant women, their partners, and OB health or genetic counseling professionals provided the initial data for development. Then, iterative team meetings with game engineers, geneticists, obstetricians, nurse midwives, social scientists, and health communication experts were then conducted to develop and implement the game for this study. The game experience was driven by an exploration of risk estimates for positive and negative screening outcomes and diagnostic testing outcomes by the woman's maternal age. Participants were able to "click" through various age groups of the pregnant avatars and see outcomes and likelihood of positive and negative results, including false-positives and false-negatives



Fig. 1 Pregnant women by age.

from prenatal screening through diagnostic testing outcomes (→Figs. 1 and 2). As participants “clicked” through various outcomes, they were encouraged to have the avatars talk to each other about facts and reasons for pursuing or not pursuing prenatal screening. To address concerns regarding health literacy and numeracy, the number of avatars was represented to reflect the actual risk of these outcomes. For example, if there was a 1 in 100 chance of a false-positive, then 1 avatar was put under that outcome and 100 avatars were placed on the other side of the screen. The design layout of the game was pleasant, with bright colors and an agreeable outdoor environment that included trees, grass, and a river.

Surveys

Participants in both groups completed a knowledge survey about prenatal screening and diagnostic testing. Knowledge was measured with a 23-item survey (Prenatal Screening Knowledge Survey) developed by an expert panel of genetic counselors, physicians, social scientists, and data collection experts. Internal consistency was excellent in our sample ($N = 73$) with a Cronbach's $\alpha = 0.78$ (see →**Supplementary Material** [available in the online version] for a list of questions).

The International Patient Aid Decision Aids Standards (IPDAS) Collaboration published a checklist of the criteria that should be included in a well-designed decision aids.¹⁴ Values clarification exercises were included as a critical component in the checklist. Values clarification exercises are processes to aid patients in clarifying their values and goals and improving alignment of patients' preferences with the treatments they actually receive. The survey included eight questions about values modified from Kuppermann et al.³ Screening uptake and genetic counseling were abstracted from the chart review to examine whether participants pursued prenatal screening after completing the study and to control for participants who may have pursued prenatal screening or seen a genetic counselor prior to completion of this study (after the first prenatal visit and before the second prenatal visit). Surveys also included questions about the game in regard to neutrality of information, satisfaction with the prenatal screening education process, and satisfaction with the gaming experience. Finally, data analytics on game usage were also collected.

General linear modeling with SPSS Version 24 (corrected for inequality of variance where warranted) and chi-square

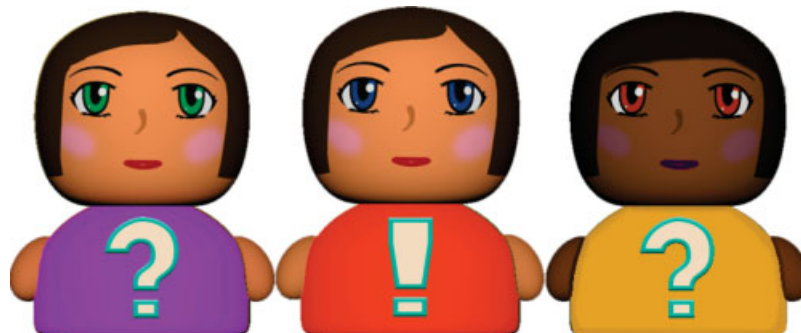


Fig. 2 Avatars.

testing was used to assess group differences in knowledge, values, and screening/genetic counseling behavior. Spearman's rank correlation coefficient was used to assess the relationship between game usage (time and click data) and the outcome variables. The study was powered a priori (0.80), $\alpha = 0.05$, to detect a medium/large effect size (Cohen's $d = 0.67$) for the primary outcome of knowledge, assuming an 80% correct knowledge response, a standard deviation of 3% with equal groups of 36 participants.

Results

Seventy-nine participants were randomized to the two groups: 39 in the control group and 40 in the intervention group. There was a technical fault with the data analytics function for the Meaning of Screening game for the first three participants in the intervention group, and these participants were dropped from the analysis. Three participants exited the game within 20 seconds of beginning the game and were dropped from the analysis making our total sample ($N = 73$; 39 in the control group and 34 in the intervention group) (see CONSORT [CONsolidated Standards Of Reporting Trials] diagram in ►Fig. 3).

The groups were equivalent on demographic variables (►Table 1). The average age of our participants was 29.82 (4.96) years old, 80% were White and 84% were Non-Hispanic,

Table 1 Demographics

Characteristics	Standard of care	Meaning of screening	Total
	<i>n</i> = 39	<i>n</i> = 34	<i>n</i> = 73
Age at enrollment (years)	29.56 (5.20)	30.13 (4.72)	29.82 (4.96)
Race			
White	33 (84.6%)	25 (73.5%)	58 (79.5%)
Non-White	6 (15.4%)	9 (26.5%)	15 (20.5%)
Ethnicity			
Hispanic	4 (10.3%)	7 (22.6%)	11 (15.7%)
Non-Hispanic	35 (89.7%)	24 (77.4%)	59 (84.3%)
Income			
Under US\$24,999	4 (10.5%)	1 (3.1%)	5 (7.1%)
US\$25,000–US\$50,000	7 (18.4%)	5 (15.6%)	12 (17.1%)
US\$50,001–US\$100,000	14 (36.8%)	16 (50%)	30 (42.9%)
US\$100,001–US\$150,000	8 (21.1%)	5 (15.6%)	13 (18.6%)
Over US\$150,000	2 (5.3%)	2 (6.3%)	4 (5.7%)
Not sure/did not answer	3 (7.9%)	3 (9.4%)	6 (8.6%)
Education			
Less than college graduate	12 (30.8%)	12 (37.5%)	24 (33.8%)
College graduate and above	27 (69.2%)	20 (62.5%)	47 (66.2%)

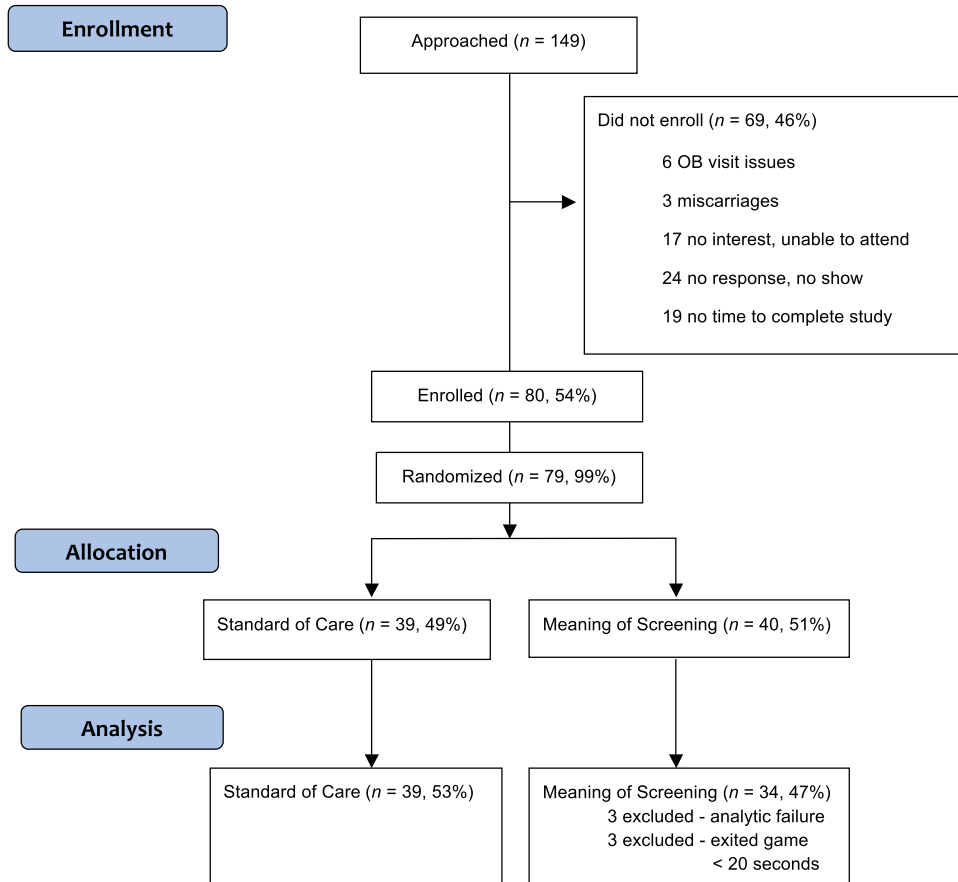


Fig. 3 CONSORT flow diagram. OB, obstetric.

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Table 2 Knowledge, values, and screening behavior

Outcome	Standard of care, <i>n</i> = 39	Meaning of screening, <i>n</i> = 34	<i>p</i> -Value
Knowledge			
Knowledge total score ^a	19.59 (3.31)	21.41 (1.74)	0.004
Values			
Which would be harder for you: having a child with Down's syndrome or having a miscarriage that may be caused by a prenatal test? ^b	3.85 (1.23)	3.24 (1.33)	0.045
If you were told that your fetus had Down's syndrome, would you choose to have an abortion? ^c	1.44 (0.94)	1.97 (1.22)	0.051
Screening behavior			
Received screening after study	6 (15%)	11 (32%)	0.087

^aNumber correct of 23 knowledge items.

^bSingle-item 1 to 5 scale (1, definitely worse to have a child with Down's syndrome; 5, definitely worse to have a miscarriage).

^cSingle-item 1 to 5 scale (1, no, I definitely would not have an abortion; 5, yes, I definitely would have an abortion).

66% had graduated college or more formal education, and 43% had an income between \$50,001 and \$150,000.

As hypothesized, participants randomized to the intervention group had significantly higher knowledge scores ($m = 21.41$; standard deviation [SD] = 1.74) than participants in the control group ($m = 19.59$; SD = 3.31), $p = 0.004$ (see ►Table 2 for the results).

Value clarification questions were also asked to control for beliefs regarding Down's syndrome and risks associated with diagnostic testing. For example, if participants self-reported values that indicated that they were more likely to risk a miscarriage from invasive screening tests than have a child with Down's syndrome, then these individuals were coded as "more likely to engage in prenatal screening." Participants in the two groups only significantly differed on two value questions. When asked, "Which would be harder for you, having a child with Down's syndrome or having a miscarriage that may be caused by a prenatal test?" participants playing the game reported higher scores toward harder having a child with Down's syndrome ($m = 3.85$; SD = 1.23) than those participants in the control group ($m = 3.24$; SD = 1.28), $p = 0.045$. The other question was "If you were told that your fetus had Down's syndrome, would you choose to have an abortion?" and participants playing the game reported higher scores toward termination ($m = 1.97$; SD = 1.22) than those in the control group ($m = 1.44$; SD = 0.94), $p = 0.051$. These variables were added as covariates to the analysis and did not significantly influence prenatal screening uptake between the two groups. All the other value questions were statistically equivalent between the groups.

To assess the efficacy of the game and to evaluate whether it influenced participants to take a particular screening decision, screening uptake and genetic counseling were obtained from the chart review. The groups were similar in frequency of having screening after the study (control = 6 [15%] vs. intervention = 11 [32%]; $p = 0.087$).

The median time of game playing was 6:43 (range: 2:17–16:44) and the median number of clicks on items within the game was 49 (range: 14–242). Time spent playing the game was not correlated with any of the outcomes. The number of clicks was correlated with the behavior of having screening performed after the study ($r_s = 0.36$; $p = 0.037$). For participants in the control group, official time for reviewing the brochure was approximately 1 to 2 minutes as reported by research coordinators. Satisfaction results with the game decision aid are presented in ►Table 3.

Discussion

Gaming is a pervasive aspect of American culture. About 60% of all Americans play computer or video games during their leisure time, and in most of those cases, they play for at least 3 hours per week.¹⁵ The average age of a player in the United States is 35 years old, and 41% of game players are women. In fact, women aged 18 or older represent a significantly greater portion of the game-playing population than boys aged 18 or younger.¹⁵ The widespread appeal of games among adults creates a unique opportunity for education within health care, allowing patients to actively engage with information, or play with it, as opposed to absorbing it in a didactic fashion.

This study developed and evaluated the efficacy of a game-based decision aid for prenatal screening among a general population of pregnant women compared with usual care (brochure-based decision aid). The results demonstrated high satisfaction and more time interacting with the information about prenatal screening in a game format that resulted in significantly higher knowledge outcomes. Furthermore, there were no differences between the two groups in prenatal screening uptake after the study. In general, the use of a game decision aid in this study suggests a new approach to promoting informed decision-making among pregnant women.

Table 3 Satisfaction with the game decision tool

Questions about the game experience (n = 34)	Percentage
How would you rate the amount of information you just received about prenatal testing?	2.9%: a little more than I needed 97%: about right or more than I needed 2.9%: a lot less than I needed
How clearly was that information presented?	50%: everything was clear 47.1%: most things were clear 2.9%: many things were unclear
How balanced (both the pros and cons) was the information in the game?	17.6%: clearly slanted toward screening 32.4%: slightly slanted toward screening 50%: completely balanced
Were there any tests or procedures that you were hoping to learn about but were unable to find in the program?	94.1%: reported "no" 5.9%: reported "yes"
Were there any testing strategies that you were interested in that were not discussed by the game?	97.1%: reported "no" 2.9%: reported "yes"
I would recommend this game to a friend who is pregnant.	88.3%: agree or strongly agree 11.7%: probably not or no
I have a positive opinion toward video games.	42%: agree or strongly agree 38.7%: neither agree nor disagree 19.4%: disagree
Playing this game was a new kind of experience for me.	67.7%: agree 19.4%: neither agree nor disagree 12.9%: disagree or strongly disagree
I found the experience worthwhile.	73.5%: agree or strongly agree 12.9%: neither agree nor disagree 6.4%: disagree or strongly disagree

Despite improved knowledge outcomes and high satisfaction with this type of decision aid, more in-depth research is needed to assess how the features of games specifically address the components of a decision aid, such as values clarification, decisional conflict, and shared decision-making with providers. Both values clarification and shared decision-making with providers are extremely important in this domain of prenatal care partly due to the voluntary nature of this type of screening test. Research has shown that information about prenatal screening is often offered to patients based on the perceptions by their prenatal care providers, including perceptions about risk and about whether a couple is likely to want or use the screening results.^{16,17} Regardless of the prenatal screening decision made by the couple or pregnant woman, clearly the decisions are heavily influenced by how, if at all, the provider communicates the screening options and information.^{17,18} More research is needed to assess how a game that allows exploration of different choices impacts shared decision-making with providers.

In addition, different choices and the potential outcomes of these choices as they relate to personal values and pregnancy outcomes could also be explored, which, in turn, may assist in more informed decision-making. Values are principles or standards of behavior an individual deems highly important

in life. As discussed previously, values clarification is a critical component in decision aids, and games may be an ideal modality to explore different outcomes of prenatal screening from varying types of results. Thus, pregnancy outcomes of a diagnosis of a fetus with Down's syndrome or termination could be explored in a game setting that is private and allows more personal reflection prior to decision-making about prenatal screening. Future addition to the decision aid game could add these potential outcomes.

In addition, there were some interesting results relating to the appropriate use of a game format for a decision aid on health care decisions. Those who "clicked" more on the avatars to learn facts, and ask and answer questions between the avatars also had a higher uptake of prenatal screening. This could have been a spurious finding because time playing the game was not associated with prenatal screening uptake. However, it is interesting that increased interactivity with the game, self-driven by the woman, is associated with higher screening uptake but not with differences in knowledge. One possibility is that the process of seeing avatars, which reflect a diverse group of pregnant women discuss facts and questions about prenatal screening, may result in a more positive perspective toward screening. Alternatively, women who were predisposed to pursue testing may have spent more time with the game to better understand prenatal screening. Furthermore, the visual layout of the game was also positive in bright colors and a pleasant outdoor environment. However, this also made the game more attractive and resulted in more time spent with the game than the brochure.

Thus, the features that make games interesting may also promote a more positive attitude toward prenatal screening as opposed to not screening. It is important to maintain a non-directive nature in education for prenatal screening, and that may pose significant challenges for the game context. Games often are engaging through the provision of rewards to the gamer for success in working through barriers and problems toward an ultimate goal. In the health care domain, games can use such reward strategies to promote knowledge and adherence to professional recommendations. In our context, our goal is to neither promote nor inhibit prenatal screening per se but to promote informed decision-making, values clarification, and communication between partners driven by theory through serious game design. More research is needed to identify how these game features such as color scheme, game environment, and interactions and physical representation of avatars influence decision-making.

This study used a randomized design with a focus on screening choices including some information about diagnostic outcomes. However, it only included outcome data on cell-free DNA (cfDNA) and did not include outcome data that compared and contrasted cfDNA with other prenatal screening options. The research team purposefully limited the game to cfDNA at this stage of the research because implications for counseling and informed decision-making of pregnant women are similar for other prenatal screening tests. Despite cfDNA having better detection rate among older women,¹⁹ the general approach to education about prenatal screening across the different options is the same.

Most OB clinics provide brochures at the first prenatal visit,²⁰ and some may or may not discuss the options with their obstetrician and/or a genetic counselor. cfDNA was chosen because it has a better overall detection rate, and the purpose of the game was not to educate about each type of prenatal screening option and how each type of screening is conducted but if prenatal screening was an appropriate choice in general.

In addition, this study was only able to include a small sample of women with limited diversity from an OB clinic of an academic urban medical center. Next steps for the game design will need to include value preferences of the patient into the game as opposed to computerized survey questions to increase personalization prior to decision-making. Knowledge was only assessed *after* the intervention so that we are unable to explore knowledge gains over time. Finally, it is important that any future research assesses the neutrality of a gaming decision aid on outcomes. Any decision support tool should not encourage or discourage a particular choice and additional research on how entertainment or pleasant visual features may impact decisions without bias as well as how it impacts shared decision-making with providers is needed. Future research will explore the impact of this game with a more diverse sample, both nationally and in terms of racial/ethnic makeup.

Conclusion

Outcomes of this research show promise for the use of games to educate about prenatal screening as well as other genetic testing decisions. The game environment appeared to motivate participants to interact more with the information, resulting in higher knowledge. More research is needed to understand how the features of a game influence motivation to continue to play and impact patient decision-making and decisional outcomes.

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Conflict of Interest

None.

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