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SHAPING THE FUTURE: EXPLORING THE IMPACT OF DIGITAL HEALTH MESSAGES AND COMMUNICATION ON PROTECTION ACTION MOTIVATION TO ADOPT PREMARITAL GENETIC TESTING

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Summary

Background. The research area of health communication is expanding, and digital media is being widely studied. Although digital media and digital health information are pervasive, there is a huge gap in research on how they affect people's behavior. The research explores the efficacy of digital health messages and communication strategies in enhancing health literacy and health behavior interventions. The research integrated the protection action decision model and the theory of normative social behavior.

Material and methods. The study employs a cross-sectional online survey to collect data from 520 unmarried, separated and divorced adults with potential future marriages.

Results. The results verified that digital health messages from health authorities could ingrain the risk perception about genetic diseases and protective action perception of premarital screening, resulting in protection motivation. Likewise, the normative factor of the injunctive norm was surprisingly not significant. Digital health messages promote outcome expectations

and perceptions about genetic diseases, intensifying protection motivation and the relationship between descriptive norms.

Conclusions. The research clarified that regardless of prevailing normative beliefs about premarital testing, health messages disseminated from health authorities' digital platforms can ingrain a greater extent of perceived risk, protective action, and outcome expectations, enhancing motivation to adopt premarital genetic testing.

Keywords: premarital screening, digital media, genetic disorders, health communication, World Health Organization

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Introduction

The risks associated with gene abnormalities and the necessity for prenatal testing, counselling, and the diagnosis of genetic disorders have grown worldwide in the past decade [1]. A significant number of genetic disorders are fatal or severely disabling conditions. The primary goal of premarital testing is to inform carrier couples of the potential risk of conceiving a genetically impaired child and enable them to consider all preventive options [2]. Consultation for premarital testing is essential for couples at risk of congenital birth defects, advocating for premarital testing and acknowledging potential dangers post-conception [3]. It can identify prevalent genetic disorders such as sickle cell anaemia, thalassemia, and Down syndrome. Premarital screening is crucial as it informs expecting married couples about any potential risk of genetic problems in future children. Premarital testing enables healthcare practitioners to teach couples about the principles of a healthy family and the well-being of future children. Premarital genetic screening facilitates the early identification of genetic disorders to avoid or mitigate disease progression and to optimise risk management [4]. Premarital genetic testing can identify and modify behavioral, medical, and other health risk factors. The risks

have affected pregnancy outcomes through prevention and intervention. Certainly, premarital screening is principally designed to provide couples with medical counsel regarding the probability of transmitting genetic disorders to their children.

Accordingly, it is essential to disseminate and promote knowledge about premarital testing at the individual, familial, and community levels, primarily via media and healthcare practitioners. Essential health communication campaigns and interventions in behavior change processes offer a structured planning and evaluation framework. Human health behaviors are intricate and varied [5]. However, they can determine the success or failure of managing individual and public health issues.

Premarital screening has been accepted in obstetrics across several countries. It represents an important ethical choice that individuals should make according to their convictions and ideals [4]. Many studies have been undertaken to investigate individuals' protection action motivation regarding their willingness to consent to or oppose premarital screening practices. Numerous research studies concentrate on social, emotional, and psychological dimensions of decision-making [6]. Recent studies on premarital screening and genetic disorders focus on the knowledge, attitudes, awareness, and behaviors related to premarital screening [6-10]. The studies investigated the knowledge of consanguineous marriage and genetic disorders, the effectiveness of premarital screening, and factors influencing the intention to undertake the screening. Few studies have investigated the social norms regarding premarital testing and how they influence decision-making for premarital screening within religious groups.

However, there is a lack of research in the area. For instance, past studies used mainly normative theories in diverse contexts, but genetic screening and related normative issues are yet to be investigated in the Global South. The research examines how injunctive norms and outcome expectations relate to descriptive norms in predicting protection action motivation.

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Likewise, to our knowledge, an absence of literature provides evidence on the role of digital health messages (DHM). Digital platforms are widely used for health promotion, but how people respond to genetic disease-related messages is unclear, particularly in a country where unmarried people's decisions on genetic screening can be less known and can be a sensitive issue. Health hazards are restricted by society's lack of access to precise facts about genetic diseases, and prompt action is needed with the promising role of digital media and health authorities such as the World Health Organization (WHO) in spreading health messages. There is a growing emphasis on leveraging the platforms and knowing their efficacy. The platforms offer a cost-effective means to enhance public awareness about common genetic disorders and premarital screening**.** However, despite the potential of health to promote preventive health behaviors against genetic disorders, their precise impact remains unclear.

To address the gap, the study utilized the tenets of the theory of normative social behavior. In times of uncertainty, individuals frequently observe others to acquire behavioral and interactional cues [11]. In health communication, elevated levels of risk perception enhance an individuals' engagement in health-protective behavioral protection action motivation to mitigate risk, perhaps resulting in tangible behavioral outcomes [12]. The availability of risk information can substantially influence risk perceptions, subsequently altering the effects of the beliefs on behaviors related to genetic disorders [13]. To this end, genetic screening as a protective behavior is important for risk management; thereby, this study underpinned critical questions such as how health communication messages through digital platforms. Furthermore, the research integrated the normative factors discussed in the tenets of the theory of normative social behavior (TNSB) with the protective action decision model to evaluate the efficacy of DHM by health authorities in the unique context of Pakistan. In this standard, the research provides timely information for the health authorities to understand the dynamics of public response. The evidence in the study is critical for the risk management of genetic disorders. It

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offers insight into the implications of digital health communication's promotional role for genetic screening preventive measures.

Aim of the work

Understanding the pivotal influence of social norms on health behavior, communication academics have utilized the TNSB to guide the development and evaluation of communication campaigns and interventions [14]. The TNSB examines the impact of perceptions on the occurrence of a behavior (descriptive norms) and the acceptability of the conduct to others (injunctive norms) on health behaviors and evaluates the modified TNSB to incorporate collective norms with descriptive and injunctive norms [15]. Over the past few decades, there has been a significant increase in the quantity and quality of information available regarding health care. Personalized health information is also more readily accessible; for instance, numerous websites offer the knowledge of risk factors that enable individuals to determine their risk of developing a variety of malignancies [16].

Learning health information, such as information regarding one's disease risk or health status, can be helpful as it may help practice appropriate preventive behaviors. Nevertheless, individuals exhibit variance in their decision about whether to pursue or avoid health information despite the accessibility and utility of this information [17]. For instance, individuals may exhibit varying levels of interest in determining their disease risk or participating in cancer screening initiativeswhich may provide information about their health status [18].

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Theoretical grounds and hypothesis formation

The TNSB [15,19] illustrates the impact of normative ideas on behaviors. The basic application of the TNSB is to promote norms-based interventions [15]. Furthermore, considering the variables influencing the link between normative ideas and behaviors is significant. The major obstacles to premarital testing encompass the fear of obtaining favourable results and religious misconceptions, potentially leading to the dissolution of a planned marriage [18]. The main barriers to implementing premarital testing programs were recognized as societal, familial, and religious factors [10]. The comprehensive framework of normative social behavior acknowledges and studies social norms at both group and individual levels and their influence on particular actions, further supporting protective actions [11]. The original argument of the TNSB encompasses two categories of norms: descriptive and injunctive. Descriptive norms refer to individuals' beliefs about the prevalence of evident behaviors, encapsulating opinions on the likelihood and attributes of the behaviors exhibited by other group members [15]. Injunctive norms refer to assessments of what is socially desirable or sanctioned in a particular context. The TNSB predicts that injunctive norms mediate behavior, modulating or mediating the relationship between attitudes and behaviors. The impact of descriptive norms on behaviors is amplified when injunctive norms are strong and diminished when injunctive norms are weak [19]. The impact of norms will likely intensify when injunctive and descriptive norms align, as frequently observed [14].

Perceived norms are categorized into descriptive and injunctive [15]. The two unique norms have been systematically applied and evaluated within the framework of the TNSB to investigate the circumstances under which norms are anticipated to affect behavior across various situations. The TNSB has specifically served as a framework for examining the correlation between descriptive norms and diverse health-related behaviors [20]. The study

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employed the TNSB to examine the interaction of various norms on the protection action motivation to undergo premarital genetic disease testing.

Individuals may apply descriptive and injunctive standards collectively or individually, according to the situation. Furthermore, research has claimed that descriptive norms influence behaviors but also identified a few critical moderating factors that may impact the intensity of the influence of norms [21]. Furthermore, injunctive norms, defined as individuals' views of societal expectations, govern the correlation between descriptive standards and behaviors. Numerous research has demonstrated that injunctive and descriptive norms interplay to affect behaviors. Furthermore, individuals are more inclined to participate in behaviors when they recognize that many of their peers are doing so and believe others desire them to participate [22]. Aligned with the literature, we posit that: *H1. Descriptive norms positively influence the protection action motivation against genetic diseases (premarital genetic screening).*

Injunctive norms directly influence behaviors and moderate the relationship between descriptive norms and behaviors [19,21]. The TNSB posits that perceived injunctive norms moderate the relationship between perceived descriptive norms and behaviors, explaining why the relationship between perceived descriptive norms and behaviors becomes more potent when the injunctive norms are strong [19]. Several empirical studies have consistently supported the initial predictions of the TNSB regarding the interaction between descriptive norms and injunctive norms in health-related behaviors [11,19,21-23]. Considering the influence of injunctive norms on behavior and their moderating effect on the relationship between descriptive norms and behavior, we propose that: *H2. Injunctive norms moderate the relationship between descriptive norms and protection action motivation against genetic diseases (premarital genetic screening).*

Moreover, the TNSB identified that outcome expectations moderate the interaction between perceived descriptive norms and behaviors [24]. Outcome expectations pertain to the

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outcome expectations of an individual's actions [25]. Outcome expectations refer to beliefs about the likelihood that a specific behavior will lead to rewards or punishments, thus strengthening the connection between perceived descriptive norms and protection action motivation [22]. Aligned with the literature, we posit that: *H3. Outcome expectations moderate the relationship between descriptive norms and protection action motivation against genetic diseases (premarital genetic screening).*

Risk perception and protective action motivation

Health behavior models indicate that individuals' risk perception influences compliance with recommended precautions in health behaviors [26,27]. Risk perception is fundamental to various models that elucidate behaviors associated with health-related decisions, such as the Health Belief Model. Major behavioral models, including the Theory of Reasoned Action, the Theory of Planned Behavior, and the Subjective Expected Utility Theory, assert that the probability and magnitude of a potential hazard (risk perception) are crucial determinants of risk behaviors. A relationship between risk perception and protective action behaviors has frequently been identified in the protection action decision model (PADM) proposed by previous studies [28]. During the risk assessment stage, factors influencing individuals' personalization of risk involve the likelihood of an unforeseen occurrence, as well as its severity to the individual, of such a development [28]. Risk perceptions, as indicated by prior studies [13,26,29,30], relate to the degree to which individuals believe a risk involves significant consequences (i.e., perceived severity) and their vulnerability to that risk (i.e., perceived susceptibility). The psychometric paradigm of risk perceptions places uncertainty at the core of the perceptions, with the evaluation and judgment of risk influenced by various factors, including the availability of scientific knowledge, the severity of consequences, and the

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immediacy of the risk [31]. Researchers refer to the degree of certainty individuals have regarding their risk judgments as uncertainty about risk perceptions, which serves as cognitive processes of the perceptions [28]. Scholars [32] examined the perceptions of premarital screening and genetic counselling among male and female nursing students. The findings indicated that while participants held a positive attitude towards the practices, there was a notable lack of awareness regarding the diseases they address [33]. The present study assesses the risk perception of genetic diseases and its impact on the motivation to take protective actions concerning premarital testing among future couples. The study aims at assessing the risk perception of genetic diseases and its impact on protection action motivation regarding premarital testing among future couples. Drawing an analogy with the literature, we posit that: *H4. Risk perception positively influences protection action motivation against genetic diseases (premarital genetic screening).*

Protective action perceptions and protection action motivation

Protective action perceptions refer to the effectiveness of protecting individuals and the associated expenses with the necessary efforts and time, knowledge and skills, and social collaboration characteristics [26]. The risk-related characteristics reflect the Health Belief Model's perceived severity and susceptibility, whereas the resource-related attributes align with the model's self-efficacy and perceived constraints. Furthermore, protection action motivation, as indicated by Lindell et al. [28], explicitly illustrates responses to hazardous situations by evaluating the probability and severity of consequences resulting from a lack of protection action, self-efficacy, and the efficacy of protective action perceptions. Subsequently, it asserts that the perception of protective action is crucial for justifying protection action motivation, and the potential of genetic risk information for people has been explored across various health

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behavior risks. Hence, the motivation for protective perception for protection action is the motivation to modify actual health behaviors. Numerous studies indicate that certain individuals exhibit heightened protection action motivation to alter behaviors in response to genetic risk information [34]. Consistent with the literature, we posit that: *H5. Protection action perception positively influences protection action motivation against genetic diseases (premarital genetic screening).*

Digital health messages

A substantial number of studies have concentrated on health communication and the theories employed in coverage, with implications stemming from the significant impact of the media [35]. Frameworks utilize prevailing concepts, values, and standards within a particular culture to attain the goals. Consequently, frames depend upon a specific culture, suggesting that the number of news frames ought to be restricted, as that culture's dominant beliefs, values, and conventions shape them [36]. Nonetheless, there is a shortage of scholarly research regarding the representation of health behaviors on digital platforms and the communication of health issues in the contemporary landscape, mainly through authentic news presented as health messaging [37]. Consequently, analyzing how individuals utilize digital media channels to get health information is essential [38]. Digital media is a powerful outlet for promoting health initiatives and interventions, effectively reaching diverse audiences due to its extensive reach [17]. Digital media can enhance awareness of the condition and its prevention, enabling individuals to share their beneficial experiences about healthier behavioral modifications, disease side effects, and the advantageous consequences of adopting a healthy lifestyle [38,39]. The influence of digital media and risk perception on the execution of protective measures against genetic illnesses in the context of premarital testing remains unclear. The most

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productive media sequence for risk perception regarding genetic illnesses and subsequent preventative measures is digital media, specifically Instagram, WhatsApp, and X (formerly Twitter) [27]. Hence, we hypothesize that*: H6-8. DHM positively influences (H6) risk perception, (H7) protection perception against genetic diseases and (H8) outcome expectations.*

Material and methods

Research design

The research used a cross-sectional design to examine antecedents of the timely issue of premarital screening-related protective action motivation. Drawing from the past theory, the study proposed a comprehensive model to look into the role of the new phenomenon of DHM commonly employed by health authorities and organizations such as WHO to enhance compliance with protective behavior among young couples. The study was carried out in the unique context of Pakistan, whereby there are several normative issues regarding premarital genetic screening. Therefore, the study incorporated the normative and health behavior theory to examine the critical issue.

The study collected data from 520 unmarried, separated, and divorced adults using online data collection. All adults with possibilities of future marriages were considered as units of analysis for the study. The online data collection was critical due to the investigation of the efficacy of the DHM and the nature of the study. The study used digital platforms such as Facebook, mainly by health authorities and organizations such as WHO, to promote premarital genetic testing.

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For this reason, the questionnaire was administered online, and a filter question was used to participate in the survey. Those who agreed to the informed consent and declared unmarried status were invited to complete the survey. A survey link was provided for volunteer participation, and their identities were ensured to remain anonymous as per Helsinki's declaration guidelines.

The sample size was appropriate based on the number of items used for this study; for instance, scholars [40] recommended ten respondents per item is suitable for the survey. The research considered seven constructs, a total number of items of 25, and a desired sample size of 260. However, the research also followed Krejcie and Morgan's [41] table that suggested 384 as the minimum sample size for the Pakistani population (e.g., 240 million estimated) with a 5% margin of error and 95% confidence level. The demographic analysis is accessible in Table 1.

Table 1. Demographic characteristics

Gender	**Freq**	**%**
Men	336	64.6
Women	184	35.4
Age	Freq	%
18-24	138	26.5
25-30	193	37.2
35-40	152	29.2
41-50	37	7.1
50 and older	Nil	Nil
Total	520	100.0
Marital status	**Freq**	**%**
Single	482	92.8
Separated	11	2.1
Divorced	27	5.1
Total	520	100
Monthly income	**Freq**	**%**
25000-50000	87	16.7
51000-80000	126	24.3
81000-150000	171	32.9
151000-250000	103	19.8

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251000-400000	25	4.8
Above 400000	08	1.5
Educational background	**Freq**	**%**
Matriculation	23	4.4
Undergraduate or below	258	49.5
Master of above	209	40.2
Others: diploma/skilled	30	5.9
Total	520	100

Notes: *Pakistani Rupee Exchange rate: USD 1= PKR 277.

Instruments

The study underpinned the constructs from the two critical theories, the TNBS and PADM, in the context of the sensitive issue of premarital genetic screening. For that reason, the variables of risk perception, protection perception, and protective action motivation were measured using three items for each variable adopted from previous studies [30,42,43]. The descriptive norm was tapped using the 4-item scale adopted and modified from previous literature [44]. The injunctive norm was tapped using the 3-item scale adopted and modified literature. The outcome expectation was tapped using the 5-item scale adopted and modified literature [44-46]. Lastly, the dependent variable of protection action motivation operationalized in the context of genetic screening was measured using a 3-item scale. All variables were measured using the 5-point Likert scale.

Results

The study utilized the PLS-SEM structural equation modelling to verify the proposed model's reliability, validity, and assumptions. In the first phase of the analysis, the research uses PLS-SEM to assess the reliability of the proposed measurement model. The PLS-SEM analysis results evaluated the consistency of constructs. The results revealed the consistency of all

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measures and Cronbach alpha and composite reliability measure (r_ho, etc.) values above the threshold of 0.70. They suggested considerable acceptable measures to proceed (Table 2). Following the reliability evaluation, the research used the PL-SEM confirmatory analysis to measure instruments' convergent and discriminant validities by investigating the outer loadings, total variance of items average variance extracted (AVE), and heterotrait-monotrait ratio.

Table 2. Reliability

Variables	α	CR_rho_a	CR_rho_c	AVE
DN	0.882	0.883	0.918	0.738
DHM	0.746	0.748	0.855	0.663
IN	0.755	0.774	0.859	0.671
OE	0.805	0.815	0.871	0.628
PMGD	0.803	0.805	0.884	0.718
PAGS	0.713	0.715	0.802	0.576
RPGD	0.808	0.834	0.867	0.621

Notes: α – cronbach's Alpha; AVE – average variance extracted; CR_rho_a – composite reliability average inter-item correlation; rho_c – congeneric reliability; DHM – digital health messages; PMGD – protection action motivation against genetic diseases (premarital genetic screening); OE – outcome expectations; DN – descriptive norms; IN – injunctive norms; PAGS – protective action perception, RPGD – risk perception of genetic diseases.

The results are accessible in Figure 1. They report that only two items were deleted during the confirmatory factor analysis of the outer loadings. The variance inflation was also examined, and no threat of multicollinearity was found, as all items were within the acceptable range of 1 to 10.

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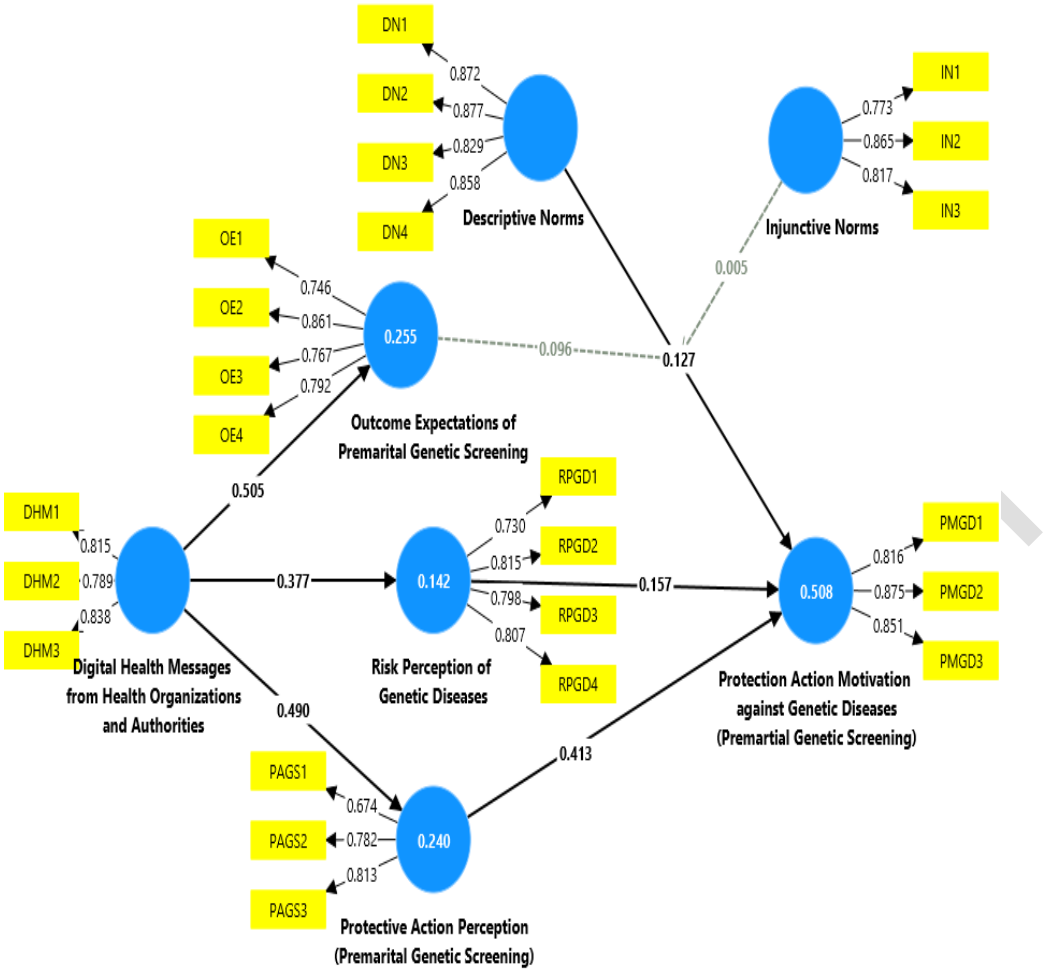

Figure 1. Measurement model

The HTMT results in Table 3 demonstrate discriminant validity. The PLS-SEM results verify the acceptable distinctiveness of the latent constructs in the study's proposed model, and no high correlation was found among them.

Table 3. Discriminant validity

Heterotrait-monotrait ratio	DN	DHM	IN	OE	PMGD	PAGS	RPGD
DHM	0.367	-	-	-	-	-	-
IN	0.748	0.450	-	-	-	-	-
OE	0.277	0.636	0.201	-	-	-	-
PMGD	0.417	0.790	0.553	0.440		-	-
PAGS	0.294	0.691	0.273	0.216	0.738	-	-
RPGD	0.281	0.453	0.278	0.494	0.371	0.623	-
OE x DN	0.355	0.076	0.251	0.191	0.130	0.177	0.281
IN x DN	0.084	0.021	0.046	0.268	0.058	0.113	0.110

Notes: DHM – digital health messages; PMGD – protection action motivation against genetic diseases (premarital genetic screening); OE – outcome expectations; DN – descriptive norms; IN – injunctive norms; PAGS – protective action perception; RPGD – risk perception of genetic diseases, x – interaction term.

The PLS-SEM is an effective method for assessing composite relations between numerous constructs and is widely used in social sciences and communication inquiries. The study employed the PLS-SEM to verify the eight hypotheses proposed in the study, which involved six direct and two moderating hypotheses. H1 assumed that descriptive norms positively influence the protection action motivation regarding premarital genetic screening tests (hereafter the PMGD), and results supported the hypothesis (β= 0.127 and *p*=0.005). H2 assumed that injunctive norms moderate the relationship between descriptive norms and the PMGD. However, the results did not support the hypothesis (β= 0.005 and *p*=0.906). The interesting implications are discussed in the former section. H3 assumed that outcome expectations moderate the relationship between descriptive norms and the PMGD, and results supported the hypothesis (β= 0.096 and *p*=0.004).

H4 assumed that risk perception positively influences the PMGD, and results supported the hypothesis (β= 0.157 and *p*=0.001). While H5 assumed protection action perception positively influences the PMGD, results supported the hypothesis (β= 0.413 and *p*=0.000). Finally, the study posited that DHM positively influences (H6) risk perception, (H7) protection perception against genetic diseases, and (H8) outcome expectations. The results verified H6, H7, and H8 (Table 4 and Figure 2). The model overall revealed a variance of more than 50%. R-square values are accessible in Figure 2, and the proposed research revealed a satisfactory prediction of the PMGD.

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Table 4. Results

Path	β	T_statistics	*p*	Results
DN -> PMGD	0.127	2.789	0.005	H1 supported
IN x DN -> PMGD (Moderating)	0.005	0.118	0.906	H2 unsupported
OE x DN -> PMGD (Moderating)	0.096	2.865	0.004	H3 supported
RPGD -> PMGD	0.157	3.269	0.001	H4 supported
PAGS -> PMGD	0.413	9.180	0.000	H5 supported
DHM -> RPGD	0.377	8.176	0.000	H6 supported
DHM -> PAGS	0.490	9.965	0.000	H7 supported
DHM -> OE	0.505	11.065	0.000	H5 supported

Notes: DHM – digital health messages; PMGD – protection action motivation against genetic diseases (premarital genetic screening); OE – outcome expectations; DN – descriptive norms; IN – injunctive norms; PAGS – protective action perception; RPGD – risk perception of genetic diseases; T_statistics – statistical significance of a predictor variable; β – standardized regression coefficient; p – probability; x – interaction term.

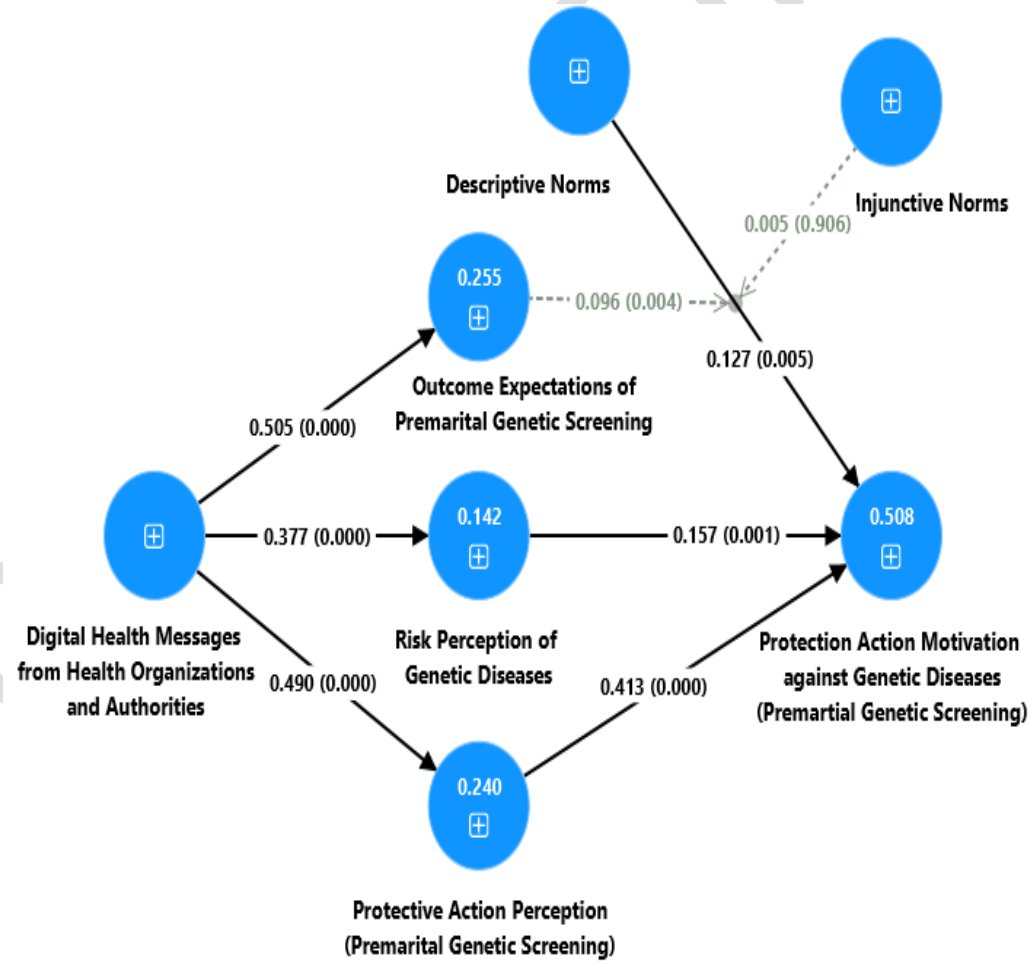

Figure 2. Path analysis PLS output

Discussion

Genetic diseases and their treatments impose substantial social and financial burdens on affected individuals. Among the conditions, thalassemia is a particularly severe genetic disorder, and its prevention hinges largely on premarital screening [43]. The introduction of premarital screening programs has begun to address genetic disease challenges systematically. WHOhas recommended implementing premarital screening for genetic disorders alongside training healthcare providers and disseminating information to the public [9]. Premarital evaluations are crucial in identifying genetic risks among prospective couples [6]. The research points to the potential of digital health media for educating and promoting preventive measures regarding genetic diseases among premarital couples. Media-based education enhances knowledge and attitudes, promoting behavior, improving nutritional health, and preventing stunting.

The research used the TNSB, a valuable framework for health communication research, as it illuminates the cognitive processes and conditional relationships that dictate how social norms influence protection action motivation and behaviors. Numerous studies validate the principles of the TNSB (e.g.,). Social norms, shaped by factors like religion, ethnicity, demographics, and socioeconomic conditions, significantly impact the prevalence of consanguineous marriages. Injunctive norms, representing societal expectations for acceptable behavior, influence attitudes and actions, especially when emphasized. A cultural standpoint of injunctive norms refers to the behaviors that are either approved or disapproved by society. Injunctive norms signify societal expectations about what is expected to be done to conform to society [15]. In the context of genetic diseases and premarital testing in Pakistan, injunctive norms are shaped by cultural, religious, and social frameworks and play a substantial role in influencing decisions related to health. Specifically, in the Pakistani society, where culture and

traditional mindset play a significant role, genetic diseases and premarital testing can lead to social stigmatization. Consequently, injunctive norms regarding genetic testing and premarital testing are associated with collectivist cultural values, where the reputation of family, social standing and harmony and, more importantly, social stigmatization often outweigh individual health concerns. This is why decisions about premarital testing frequently involve fear of isolation from family and reflecting how cultural norms influence personal choices. In a nutshell, conformity to injunctive norms can result in avoiding premarital testing intentions due to fear of community disapproval and disruption of marriage life. Hence, addressing injunctive norms through culturally sensitive health communication can help mitigate the genetic disease burden in the country and promote premarital testing.

The study assumed a moderating relationship between descriptive norms and behaviors and can independently shape behavioral outcomes [11,15]. However, H2 results of the study revealed interesting findings and injunctive norms were found to be insignificant. In strong DHM, the outcome expectations can be taught (H8) and further intensify the PMGD. The results are in contrast with Western societies, wherein often adopt individualistic values with personal autonomy regarding premarital testing. Consequently, injunctive norms illustrate proactive personal choices [24,42]. Hence, they take informed decisions precedence over societal approval. Specifically, the influence of injunctive norms in Western societies emphasizes individual health responsibilities where genetic diseases are concerned rather than a potential source of labialization and taboo. In societies without cultural and religious influence, premartial testing is taken as a personal care issue without any collective cultural normative influence.

Furthermore, norms surrounding premarital testing for genetic diseases differ in the Pakistani society and Western culture, as attributed to the enormous difference in religious, societal and cultural values. Perceptions of health responsibilities are significantly different in

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the Pakistani society due to collective group norms and social approval as compared to Western contexts [15,44]. There is a robust need to shift injunctive norms through digital media campaigns in the Pakistani community to emphasize preventive measures regarding genetic diseases in the form of premarital screening that aligns with both public and personal health goals. For instance, the use of public service messages like short videos on platforms like TikTok can assist public health managers in promoting premarital genetic testing.

The findings of the study align with research by Susanto et al. [44], which demonstrated improved behaviors following health counselling interventions delivered through audio-visual and non-audiovisual media. Before counselling, participants often exhibited negative behaviors, which significantly improved post-intervention. Health education initiatives aim at fostering positive behaviors related to knowledge, attitudes, and actions about health [11]. Premarital testing, particularly for prospective brides and grooms, underscores the importance of health-promoting behaviors in preventing genetic diseases. Interventions targeting individuals preparing for parenthood are highly effective. Such efforts cultivate good knowledge and attitudes, positively influencing the nutritional status of prospective parents, which, in turn, impacts maternal health, fetal development, and infant outcomes [47].

Remarkably, the results of H6, H7, and H8 highlighted the critical role of DHM. For instance, the results clarified that DHM is essential for improving risk perception (H6) and inculcating protective action-oriented perception (H5). It is critical for the public in making decisions about premarital testing.

Conclusions

The study concludes that DHM can provide incredible informational support to people. The results have critical lessons for public health promotion. For example, unmarried people

from a culturally sensitive nation, such as the Pakistani, perceived genetic diseases as a serious health risk (H1) and perceived genetic screening as a solution (H2) based on their prior perception of health messages from the health authorities. Therefore, the study recommends that digital platforms be used to promote health-protective behaviors. Moreover, the results clarified that it is critical in people's protective action decision-making. The results have important practical implications for the implementation of digital health communication strategies in providing a readily manageable method to disseminate perilous health information about genetic diseases and associated health risks to unmarried adults in Pakistan. The study focused on the public service messages on genetic diseases from the health authorities through digital media. The use of digital media platforms can help health authorities enable personalized health messages in promoting awareness of genetic disease causes and the importance of genetic screening. Albeit, once genetic screening was considered a culturally sensitive issue, results clarified that digital health messages from responsible authorities have a critical role in improving risk perception about genetic diseases. Therefore, using digital platforms to disseminate timely public service messages on sensitive issues can provide access to vital information. Lastly, on the policy side, it is recommended that policymakers in Pakistan work to amend marriage registration laws by making genetic screening a mandatory requisite of marriage registration. Digital platforms of health authorities can also used for awareness of genetic screening before marriage, and they can help reduce the public health burden in Pakistan.

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References:

1. Jensen TL, Gøtzsche CR, Woldbye DPD. Current and future prospects for gene therapy for rare genetic diseases affecting the brain and spinal cord. Front Mol Neurosci. 2021; 14. https://doi.org/10.3389/fnmol.2021.695937
2. Caroselli S, Poli M, Gatta V, Stuppia L, Capalbo A. Preconception carrier screening and preimplantation genetic testing in the infertility management. Andrology. Forthcoming 2024. https://doi.org/10.1111/andr.13744
3. Iqbal S, Zakar R, Fischer F, Zakar MZ. Consanguineous marriages and their association with women's reproductive health and fertility behavior in Pakistan: secondary data analysis from Demographic and Health Surveys, 1990-2018. BMC Womens Health. 2022; 22: 118. https://doi.org/10.1186/s12905-022-01704-2

ONLINE FIRST

4. Natarajan J, Joseph MA. Premarital screening for genetic blood disorders — an integrated review on the knowledge and attitudes of Middle Eastern university students. Middle East Fertil Soc J. 2021; 26: 19. https://doi.org/10.1186/s43043-021-00065-4
5. Alkalbani A, Alharrasi M, Achura S, Al Badi A, Al Rumhi A, Alqassabi K, et al. Factors affecting the willingness to undertake premarital screening test among prospective marital individuals. SAGE Open Nurs. 2022;8. https://doi.org/10.1177/23779608221078156
6. Jameel T, Baig M, Murad MA, Gazzaz ZJ, Mal Y, Alyoubi WE, et al. Consanguineous marriages, premarital screening, and genetic testing: a survey among Saudi university students. Front Public Health. 2024; 12. https://doi.org/10.3389/fpubh.2024.1328300
7. Linga BSG, Mohammed SGAA, Farrell T, Rifai H Al, Al-Dewik N, Qoronfleh MW. Genomic newborn screening for pediatric cancer predisposition syndromes: a holistic approach. Cancers (Basel). 2024; 16(11). https://doi.org/10.3390/cancers16112017
8. Agbozo WK, Amanor E, Acheampong EO, Kotei B, Attoh LN, Yeboah D, et al. Assessing knowledge of sickle cell disease and health beliefs on premarital genetic screening among healthcare trainees at a tertiary institution: A cross-sectional study. Health Sci. Rep.. 2023; 6. https://doi.org/10.1002/hsr2.1128
9. Almoliky MA, Abdulrhman H, Safe SH, Galal M, Abdu H, Towfiq B, et al. Knowledge and attitude of engaged and recently married couples toward premarital screening: a cross-sectional study. Inquiry (United States). 2022; 59. https://doi.org/10.1177/00469580221097424
10. Pokharel M, Lillie HM, Jensen JD, King AJ, Ratcliff CL, Barbour JB. political party collective norms, perceived norms, and mask wearing behavior: a test of the theory of normative social behavior. Health Commun. 2024. 39(13): 3170-3179. https://doi.org/10.1080/10410236.2024.2309003

ONLINE FIRST

11. Prince SE, Muskin SE, Kramer SJ, Huang SM, Blakey T, Rappold AG. Smoke on the horizon: leveling up citizen and social science to motivate health protective responses during wildfires. Humanit Soc Sci Commun. 2024; 11(1). https://doi.org/10.1057/s41599-024-02641-1
12. You Z, Zhan W, Zhang F. Online information acquisition affects food risk prevention behaviours: the roles of topic concern, information credibility and risk perception. BMC Public Health. 2023; 23(1). https://doi.org/10.1186/s12889-023-16814-1
13. Rimal RN, Lapinski MK. A re-explication of social norms, ten years later. Communication Theory. 2015; 25(4): 393-409. https://doi.org/10.1111/comt.12080
14. Chung A, Rimal RN. Social norms: a review. Review of Communication Research. 2016; 4: 1-28. https://doi.org/10.12840/issn.2255-4165.2016.04.01.008
15. Raza SH, Emenyeonu OC, Yousaf M, Iftikhar M. Citizen journalism practices during COVID-19 in spotlight: influence of user-generated contents about economic policies in perceiving government performance. Information Discovery and Delivery. 2022; 50(2): 142-54. dhttps://doi.org/10.1108/IDD-09-2020-0118
16. Liu PL, Ye JF, Ao HS, Sun S, Zheng Y, Li Q, et al. Effects of electronic personal health information technology on American women's cancer screening behaviors mediated through cancer worry: differences and similarities between 2017 and 2020. Digit Health. 2023; 9. https://doi.org/10.1177/20552076231185271
17. Richardson-Parry A, Baas C, Donde S, Ferraiolo B, Karmo M, Maravic Z, et al. Interventions to reduce cancer screening inequities: the perspective and role of patients, advocacy groups, and empowerment organisations. Int J Equity Health. 2023; 22(1). https://doi.org/10.1186/s12939-023-01841-6

ONLINE FIRST

18. Rimal RN. Modeling the relationship between descriptive norms and behaviors: a test and extension of the theory of normative social behavior (TNSB). Health Commun. 2008; 23(2): 103-116. https://doi.org/10.1080/10410230801967791
19. Yoon H, Jang Y, Lapinski MK, Turner MM, Peng TQ, Lee S. The role of collective group orientation and social norms on physical distancing behaviors for disease prevention. Health Commun. 2024. 39(13): 3108-3121. https://doi.org/10.1080/10410236.2024.2303826
20. Wasaya A, Prentice C, Hsiao A. The influence of norms on tourist behavioural intentions. Journal of Hospitality and Tourism Management. 2022; 50: 277-287. https://doi.org/10.1016/j.jhtm.2022.02.023
21. Gavrilets S, Tverskoi D, Sánchez A. Modelling social norms: an integration of the norm-utility approach with beliefs dynamics. Philosophical Transactions of the Royal Society B: Biological Sciences. 2024; 379(1897). https://doi.org/10.1098/rstb.2023.0027
22. Gauld C, Reeves C. Normative influences on young drivers' illegal smartphone use: Applying an extended Theory of Normative Social Behaviour. Accid Anal Prev. 2023; 180: 106904. https://doi.org/10.1016/j.aap.2022.106904
23. Huber S, Sattler S, Guido M. Mechanisms of perceived social norms: the mediating and moderating role of morality and outcome expectations on prescription drug misuse in the working population. Deviant Behav. 2023; 44(3): 359-380. https://doi.org/10.1080/01639625.2022.2046981
24. Min M. School culture, self-efficacy, outcome expectation, and teacher agency toward reform with curricular autonomy in South Korea: a social cognitive approach. Asia Pacific Journal of Education. 2023; 43(4): 951-967. https://doi.org/10.1080/02188791.2019.1626218

ONLINE FIRST

25. Wang F, Wei J, Huang SK, Lindell MK, Ge Y, Wei HL. Public reactions to the 2013 Chinese H7N9 Influenza outbreak: perceptions of risk, stakeholders, and protective actions. J Risk Res. 2018; 21(7): 809-833. https://doi.org/10.1080/13669877.2016.1247377
26. Horáčková K, Ochtinská H, Václavíková K, Šoukalová K, Brodský Z, Mandysová M, et al. Strategies for introducing preventive measures against respiratory diseases (influenza and COVID-19) in companies in the Czech Republic: meta-analysis. Health Prob Civil. 2023; 17(1): 12-23. https://doi.org/10.5114/hpc.2022.122274
27. Lindell MK, Perry RW. The protective action decision model: theoretical modifications and additional evidence. Risk Analysis. 2012; 32(4): 616-632. https://doi.org/10.1111/j.1539-6924.2011.01647.x
28. Lindell MK, Hwang SN. Households' perceived personal risk and responses in a multihazard environment. Risk Analysis. 2008; 28(2): 539-556. https://doi.org/10.1111/j.1539-6924.2008.01032.x
29. Guo Q, Yao N, Zhu W. How consumers' perception and information processing affect their acceptance of genetically modified foods in China: a risk communication perspective. Food Research International. 2020; 137: 109518. https://doi.org/10.1016/j.foodres.2020.109518
30. Duan T, Jiang H, Deng X, Zhang Q, Wang F. Government intervention, risk perception, and the adoption of protective action recommendations: evidence from the COVID-19 prevention and control experience of China. Int J Environ Res Public Health. 2020; 17(10). https://doi.org/10.3390/ijerph17103387
31. Firdous P, Nissar K, Ali S, Ganai BA, Shabir U, Hassan T, et al. Genetic testing of maturity-onset diabetes of the young current status and future perspectives. Front Endocrinol (Lausanne). 2018; 9. https://doi.org/10.3389/fendo.2018.00253

ONLINE FIRST

32. Al Eissa MM, Almsned F, Alkharji RR, Aldossary YM, AlQurashi R, Hawsa EA, et al. The perception of genetic diseases andpremarital screening tests in the central region of Saudi Arabia. BMC Public Health. 2024; 24(1). https://doi.org/10.1186/s12889-024-19029-0
33. Webster TH, Beal SJ, Brothers KB. Motivation in the age of genomics: why genetic findings of disease susceptibility might not motivate behavior change. Life Sciences, Society and Policy. 2013; 9: 8. https://doi.org/10.1186/2195-7819-9-8
34. Dan V, Raupp J. A systematic review of frames in news reporting of health risks: Characteristics, construct consistency vs. name diversity, and the relationship of frames to framing functions. Health Risk Soc. 2018; 20(5-6): 203-226. https://doi.org/10.1080/13698575.2018.1522422
35. Kang JA, Schulz P, Hubbard GT, Hwang J, Muldrow A, Barber B, et al. News framing of e-cigarettes: a cross-national study of the US, UK, and Korea. Commun Stud. 2021; 72(5): 937-956. https://doi.org/10.1080/10510974.2021.1975142
36. Raza SH, Ogadimma EC, Shah AA, Gorpe S. Improving community health messagreception through digital journalistic practices: mixed-method evidence on health preventive behaviors and health podcast framing for emerging health issues. Journalism. 2024; 25(9): 1956-76. https://doi.org/10.1177/14648849231194170
37. Zeballos Rivas DR, Lopez Jaldin ML, Nina Canaviri B, Portugal Escalante LF, Alanes Fernández AMC, Aguilar Ticona JP. Social media exposure, risk perception, preventive behaviors and attitudes during the COVID-19 epidemic in la Paz, Bolivia: a cross sectional study. PLoS One. 2021; 16(1): e0245859. https://doi.org/10.1371/journal.pone.0245859

ONLINE FIRST

38. Sun J, Jiang X, Gao Y, He C, Wang M, Wang X, et al. Subhealth Risk Perception Scale: development and validation of a new measure. Comput Math Methods Med. 2022; 2022: 950890. https://doi.org/10.1155/2022/9950890
39. Wei HL, Lindell MK, Prater CS, Wei J, Wang F, Ge YG. Perceived stakeholder characteristics and protective action for influenza emergencies: a comparative study of respondents in the United States and China. Int J Mass Emerg Disasters. 2018; 36(1): 52-70. https://doi.org/10.1177/028072701803600103
40. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis. Eighth edition. Hoboken: Pearson Prentice Hall; 2019.
41. Krejcie RV. Determining sample size for research activities. Educational and Psychological Measurement. 1970; 30(3): 607-610. https://doi.org/10.1177/001316447003000308
42. Liu RW, Cheng Y, Foerster TA. Modeling the relationship between perceived descriptive norms and willingness to practice COVID-19 preventative behaviors: a test of the mediation and moderation mechanisms in the Theory of Normative Social Behavior. Health Commun. 2023; 39(2): 339-351. https://doi.org/10.1080/10410236.2023.2165257
43. Raza SH, Yousaf M, Zaman U, Khan SW, Core R, Malik A. Unlocking infodemics and mysteries in COVID-19 vaccine hesitancy: nexus of conspiracy beliefs, digital informational support, psychological Well-being, and religious fatalism. Vaccine. 2023; 41(10): 1703-1715. https://doi.org/10.1016/j.vaccine.2023.01.047
44. Susanto P, Hoque ME, Shah NU, Candra AH, Hashim NMHN, Abdullah NL. Entrepreneurial orientation and performance of SMEs: the roles of marketing capabilities and social media usage. Journal of Entrepreneurship in Emerging Economies. 2023; 15(2): 379-403. https://doi.org/10.1108/JEEE-03-2021-0090

ONLINE FIRST

45. Kožená M, Mandysová M, Brodský Z, Šatera K, Horáčková K, Václavíková K. The economic and social impact of respiratory diseases on organisations. Acta Academica. 2023; 23(1):19-31. https://doi.org/10.25142/aak.2023.002

46. Václavíková K, Šoukalová K, Kožená M, Brodský Z, Mandysová M, Ochtinská H, et al. Preventive measures of respiratory diseases and impact on employee morbidity - possibilities of using electronic platforms. Mil. Med. Sci. Lett. 2024; 93(2): 206-217. 019 https://doi.org/10.31482/mmsl.2023.019

47. Versele V, Debekker P, Stok FM, Aerenhouts D, Clarys P, Deforche B, et al. Relative importance of determinants of changes in eating behavior during the transition to parenthood: priorities for future research and interventions. Nutrients. 2021; 13(7). https://doi.org/10.3390/nu13072429

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