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Adolescent Obesity-A Global Health Challenge and Call to Action

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Abstract

The escalating global prevalence of adolescent obesity presents a pressing public health concern with wide-ranging consequences. This narrative review seeks to offer readers a comprehensive examination of the current state of knowledge regarding interventions for adolescent obesity, emphasizing a theoretical and contextual viewpoint. Within this context, this article delves into the intricate dimensions of this issue and stresses the imperative of adolescent focused interventions. It highlights strategies specifically designed to address adolescent obesity, emphasizing the significance of early intervention strategies and the facilitating impact of public health campaigns; policy changes, such as those promoting healthier food environments; and comprehensive education programs. Addressing the challenges faced with implementation of such initiative, barriers and the scarcity of comprehensive data is also explored, alongside the promise of collaborative efforts and longitudinal research. By placing adolescents at the forefront and tailoring interventions to their distinct requirements, we can forge impactful approaches that empower healthier choices and counteract the challenge of obesity. Further research is needed to discern the most effective interventions, gauging their outcomes and successes to inform evidence-based practices for combatting adolescent obesity.

Keywords: Adolescent obesity, obesity prevention, adolescent health, malnutrition, lifestyle modification

1. Introduction

Adolescence, a period characterized by dynamic physical, neurodevelopmental, psychological, and social changes, holds pivotal importance in human development. Amidst this transformative phase, adolescent obesity emerges as an acute global health crisis, profoundly affecting millions of young individuals worldwide. The prevalence of overweight and obesity has surged significantly, transcending geographical boundaries, with severe obesity quadrupling over the last three decades (Cardel, Atkinson, Taveras, Holm, & Kelly, 2020).

Adolescents, representing diverse socioeconomic backgrounds, bear the brunt of this crisis, encountering detrimental effects on their health, quality of life, and overall well-being. Health complications such as atherosclerosis, hypertension, diabetes, and metabolic syndrome loom large. Notably, over 20% of adolescents in high-income countries grapple with overweight and obesity-related issues, reflecting an alarming trend (Cardel et al., 2020). High-income countries with the highest burden of overweight and obese children and adolescents include United States leading with an obesity rate of 42%, followed by New Zealand at 39%. Several other high-income countries, including Greece, Italy, Malta, and Australia, report obesity rates of 37%. Chile and Spain struggle with obesity rates of 36% and 34%, while Canada and the United Kingdom closely follow at 32% and 31%, respectively. (Gromada, Rees, & Chzhen, 2020). In North America, despite public health efforts, the prevalence of overweight and obesity has doubled in three decades, affecting nearly one-third of adolescents in Canada and the United States (Cardel et al., 2020; Skinner, Ravanbakht, Skelton, Perrin, & Armstrong, 2018). The urgency is evident, with Canada reporting a 7.8% obesity prevalence among adolescents aged 12-17 years (Pan-Canadian Health Inequalities Data Tool, 2017) and the United States witnessing concerning increases in overweight figures among girls aged 16-19 years (Skinner et al., 2018). The United Kingdom, too, contends with a persistent surge in adolescent obesity (van Jaarsveld & Gulliford, 2015).

Remarkably, this challenge transcends high-income nations. Low- and Middle-Income Countries (LMICs) in Asia, Africa, and Latin America, face a “double burden of disease” epidemic, evident in significant increases in body mass index and waist circumference (Abarca-Gómez et al., 2017). Adolescents in these regions face overweight

prevalence of 15% and obesity prevalence of 6% (Abarca-Gómez et al., 2017). These statistics highlight the urgent need for tailored interventions to address the global prevalence of overweight and obesity in young populations.

Adolescence, with its psychological shifts, growing autonomy, and diminished self-regulation, becomes a fertile ground for obesity development. The emotional, social, and physical health consequences that adolescents with obesity face necessitate immediate attention and empathetic support (Steinbeck, Lister, Gow, & Baur, 2018; Grossman et al., 2017). The significance of prevention becomes evident as the challenges of achieving lasting results through lifestyle modification intensify once obesity takes hold (Cardel et al., 2020).

Addressing adolescent obesity mandates a comprehensive approach, driven by a collective commitment to promote healthier lifestyles and foster supportive environments. In a world where the issue knows no borders and impacts diverse socioeconomic strata, collaborative efforts emerge as pivotal for securing a healthier future. Alongside, the exploration of effective adolescent focused methods for prevention, promotion of healthy lifestyle habits through environmental changes, and understanding the barriers and enablers to successful implementation take on equal importance.

The importance of public health prevention in curbing rising adolescent obesity rates cannot be overstated. The World Health Organization Commission on Ending Childhood Obesity underscores health education as one of its three key strategies, complemented by effective treatment options and the promotion of healthier environments to combat childhood and adolescent obesity (WHO, 2016). Centered on preventive measures, this article examines interventions addressing adolescent obesity, encompassing global evidence and strategies, which also include legislative interventions. The article explores substantiated strategies on a global scale, highlighting initiatives that promote healthy lifestyles and reinforce health foundations. The article also addresses barriers to implementation, underscores the need to investigate effective obesity prevention methods among adolescents, and advocates for the adoption of healthy lifestyle habits.

2. Method

This narrative review closely followed the standard conventions and format commonly seen in narrative literature reviews, as described by Rother, E. T. (2007). It aims to offer readers a comprehensive exploration of the current knowledge on interventions for obesity prevention in the adolescent population, focusing on its theoretical and contextual aspects.

This narrative review draws upon a comprehensive search of relevant literature from databases including PubMed, Medline and Google Scholar. We used specific keywords and phrases related to adolescent obesity, public health campaigns, policy changes, educational programs, built environment modifications, and legislative interventions to identify pertinent studies and articles. The search encompassed publications in English, with no date restrictions, enabling us to compile a wide selection of sources.

To ensure the quality and relevance of the selected articles, both reviewers independently reviewed and analyzed the articles. The selected articles underwent critical analysis, with a focus on their relevance to adolescent-centered strategies and interventions for combating obesity. This narrative review synthesizes the findings and discussions from these data sources to provide a comprehensive overview of the landscape of adolescent-focused obesity interventions, highlighting enablers and barriers to implementing adolescent focused interventions and highlighting areas that require further research and attention.

3. Results

3.1 Adolescent-Centered Initiatives to Combat Obesity

Initiatives, rooted in adolescent perspectives, have the potential to foster empowerment and ownership in health decisions. Through such initiatives, we can aim to combat obesity among adolescents and cultivate healthier lifestyles tailored to their unique needs.

To address the complex challenge of adolescent obesity, some countries have demonstrated notable progress by implementing legislative measures to restrict the advertising of unhealthy foods targeted at adolescents, facilitate nutrition labeling, and promote physical activity (Pinzon-Perez, Kotkin-Jaszi, & Perez, 2010). Evidently, specific statutory restrictions have been implemented by France to limit unhealthy food advertising targeting adolescents through the Public Health Code, while Ireland bans endorsements by celebrities for unhealthy foods and the UK prohibits such advertising during TV time for children under 16 (Pinzon-Perez et al., 2010).

A limited number of adolescent-focused initiatives are also being implemented, recognizing the distinct needs and preferences of young individuals in promoting healthier lives. Tailored public health campaigns have aimed to raise awareness about obesity risks and lifestyle choices among adolescents, while school-based programs offer

comprehensive nutrition and physical education catering to their specific needs (Webb & Wadden, 2017). Some empowerment initiatives have involved adolescents in designing and promoting health initiatives, encouraging a sense of ownership (Webb & Wadden, 2017). Additionally, technology-based interventions, such as mobile apps and social media, have aimed to engage adolescents and their families interactively in health promotion activities (Webb & Wadden, 2017).

Certain countries have pioneered large-scale public health interventions targeting adolescents. The “Let’s Move!” Campaign in the United States prioritizes adolescents by enhancing school nutrition and physical activity (Hankonen et al., 2016). Brazil’s “School Health Program” targets students with health education and activity promotion (Pinzon-Perez, et al., 2010; Silva et al., 2017). The UK’s “Change4Life” Campaign engages families, guiding healthier choices (Evans, Colls, & Hoerschelmann, 2011; Milton & Bauman, 2015). Finland’s “Finnish Schools on the Move” directly promotes physical activity and less sedentary behavior (Haapala et al., 2014). By focusing on adolescents, these initiatives address early intervention and the nurturing of healthier lifestyles for lasting well-being.

Table 1. Adolescent-Centered Strategies to Combat Obesity: Enablers

1. Policy and Regulation Legislative actions, guidelines, and regulations aimed at restricting the marketing of unhealthy foods to adolescents, promoting nutrition labeling, and encouraging physical activity in schools and communities.
2. Youth-Centric Public Health Campaigns Tailored messaging and media targeting adolescents to raise awareness about obesity's risks and the importance of healthy lifestyle choices.
3. Adolescent-Friendly Policy Changes Implementing policies related to nutrition labeling, school meals, and physical activity in schools to foster a supportive environment for healthy behaviors.
4. Youth Empowerment Programs Engaging adolescents in designing and promoting healthy initiatives to encourage ownership and participation in their own health.
5. School-Based Educational Programs Integrating comprehensive nutrition and physical education curricula that cater to the specific needs and interests of adolescents.
6. Community Recreation and Sports Clubs Establishing accessible and appealing recreational facilities and sports clubs to promote physical activity and social interaction among adolescents.
7. Adolescent Peer Support Networks Creating supportive environments where adolescents can share experiences, challenges, and successes related to healthy living.
8. Culturally Relevant Approaches Incorporating cultural norms and preferences into intervention strategies to make healthy behaviors more relatable and acceptable.
9. Technology-Based Interventions Utilizing mobile apps, social media, and online platforms to engage adolescents in fun and interactive health promotion activities.
10. Involvement of Parents and Caregivers Engaging parents and caregivers in obesity prevention efforts, providing guidance on healthy eating, sleeping and physical activity habits.
11. Longitudinal Research on Adolescent Obesity Conducting longitudinal studies to monitor the long-term effects of interventions and identify factors that sustain positive behavior changes.

Collaboration assumes a crucial, albeit less explored, role in initiatives targeting adolescents. Through partnerships with recreational facilities, families, and peer support networks, initiatives can synergize efforts to foster positive behavioral changes among adolescents (Gariépy, Janssen, Sentenac, & Elgar, 2013). Similarly, the advantages of engaging in longitudinal research are particularly noteworthy, given the dearth of information in this area. Longitudinal studies enable the examination of shifts in behaviors and health outcomes over an extended duration, yielding valuable insights into the enduring effectiveness and sustainability of interventions aimed at adolescents.

Supported by the literature referenced in this section, the following table 1 summarizes strategies prominently recognized as enablers in addressing adolescent obesity.

3.2 Challenges of Implementing Adolescent-Centered Initiatives to Combat Obesity

Implementing obesity-focused interventions can be challenging due to various barriers (Table 2). These challenges include policy and regulatory barriers arising from vested interests and conflicting priorities, resource

constraints leading to limited reach, and lack of coordination among stakeholders resulting in fragmented efforts. Social and cultural factors, such as eating habits influenced by norms and perceptions, can also impede behavior change (Gariépy et al., 2013).

Accessibility and availability of healthy options, along with aggressive marketing of unhealthy foods, pose additional hurdles (Powell, 2013). Modern sedentary lifestyles, stigma (Zuba & Warschburger, 2017) and parental influence also contribute to the obesity epidemic. Insufficient data on adolescent obesity prevalence and intervention effectiveness hampers evidence-based decision-making especially for low-middle-income countries (Das, Lassi, Hoodbhoy, & Salam, 2018; Salam, 2020).

Table 2. Adolescent-Centered Strategies to Combat Obesity: Barriers

1. Policy and Regulatory Barriers Vested interests from industries, political considerations, and conflicting priorities can hinder the adoption of policies and regulations related to food marketing, nutrition labeling, and physical activity.
2. Resource Constraints Limited funding and resource allocation for obesity prevention programs may lead to limited reach and impact of the interventions.
3. Lack of Coordination Inadequate coordination among various stakeholders and sectors can result in fragmented efforts and duplication of initiatives.
4. Social and Cultural Factors Cultural norms and societal perceptions may influence eating habits, physical activity and sleep patterns, making it challenging to promote behavior change.
5. Accessibility and Availability of Healthy Options Limited availability and affordability of healthy food options and recreational facilities in certain areas can hinder efforts to combat obesity.
6. Marketing and Advertising Aggressive marketing of unhealthy foods and beverages, especially targeting young audiences, can undermine efforts to promote healthy choices.
7. Lack of Data and Monitoring Insufficient data on the prevalence of adolescent obesity and the effectiveness of interventions can hamper evidence-based decision-making.
8. Changing Lifestyles Modern sedentary lifestyles characterized by increased screen time contribute to the obesity epidemic among adolescents.
9. Parental Influence Parental attitudes, behaviors, and support play a crucial role in shaping adolescent habits, making it important to involve parents in intervention strategies.
10. Stigma and Discrimination Stigmatization of individuals with obesity can deter them from seeking help or participating in intervention programs.

Successful initiatives require sustained political commitment, long-term funding, and engagement with multiple stakeholders (Koivusilta, Alanne, Kamila, & Ståhl, 2022). Community participation and culturally sensitive approaches play a crucial role (Koivusilta et al., 2022). Initiatives like public health campaigns, policy changes, educational programs, and built environment modifications need to be employed to promote healthier adolescent lifestyles and combat obesity (Koivusilta et al., 2022).

4. Discussion

Despite the existence of various strategies and initiatives, a notable dearth of information persists regarding their outcomes and overall effectiveness in combating adolescent obesity. The exploration and evaluation of such strategies and initiatives to combat adolescent obesity remain essential, encompassing various initiatives like public health campaigns, policy changes, educational programs, and built environment modifications. The value of future research extends to understanding and addressing barriers that hinder effective interventions. Rigorous assessment of outcomes will guide the identification of best practices, facilitating evidence-based and impactful approaches. Research can illuminate the ways to overcome challenges and draw insights from country examples, and highlighted enablers to inform and shape interventions that hold the potential to combat adolescent obesity.

Additionally, future research can delve deeper into the cultural and contextual factors influencing adolescent obesity, acknowledging that tailored solutions may be required. Understanding the unique influences on eating habits, physical activity, and societal perceptions will enable the development of culturally sensitive approaches that resonate with diverse populations.

Multi-sectoral collaboration, as highlighted earlier, remains a key component of successful interventions. Future research can explore innovative ways to foster collaboration between government agencies, healthcare providers, educational institutions, community organizations and the community. Identifying effective mechanisms for cooperation and communication can enhance the implementation and sustainability of interventions.

Moreover, longitudinal studies can provide valuable insights into the long-term effects of obesity-focused interventions among adolescents. Monitoring the impact over time and understanding potential relapses or sustained positive changes will contribute to refining intervention strategies for maximum effectiveness.

By continuing to invest in research on adolescent obesity interventions, we can advance the field's knowledge, strengthen evidence-based practices, and create a healthier environment for adolescents. Ultimately, this research can inform policies and practices that empower adolescents to make informed choices, embrace healthier lifestyles, and pave the way for a healthier and more prosperous future for the next generation.

5. Conclusion

As we navigate the critical public health challenge of adolescent obesity, it becomes evident that concerted efforts are required to address this multifaceted issue effectively. The global initiatives presented demonstrate the value of adolescent-centric approaches, which play a pivotal role in shaping healthier habits among adolescents. However, to truly combat adolescent obesity and its far-reaching consequences, further research is essential as it holds immense potential in advancing our understanding of effective intervention strategies.

This call-to-action urges researchers, policymakers, healthcare professionals, and communities to unite in our efforts to combat adolescent obesity. Through continued investment in research and innovative strategies, we can empower adolescents to make informed choices and embrace healthier lifestyles. Through immediate action, we can pave the way for a healthier and more prosperous future for the next generation. Together, let us rise to the challenge and make a lasting impact on the global fight against adolescent obesity.

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Advances in Treating Vasovagal Neurocardiogenic Syndrome: A Comprehensive Review of Medical Interventions

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Abstract

Neurocardiogenic vasovagal syndrome (VVS) is a common clinical condition that results in a transient loss of consciousness and inability to maintain posture, with a rapid and spontaneous recovery. Considering the technological advances regarding the effectiveness of different treatments for VVS, this article aims to review the treatment options available in the medical literature to better understand the treatment options and their potential benefits. This study is a literature review of the medical literature focused on publications from 2005 to 2022 related to the therapeutic management of VVS. Digital databases such as PubMed and SciELO were searched using the descriptors “vasovagal syncope”, “neurocardiogenic syncope” and “treatment of vasovagal syncope” to identify relevant studies. Orthostatic training (or tilt training) is a non-pharmacological approach that involves postural training performed through multiple sessions of orthostasis. Tilt training (TTr) proved to be an effective therapeutic method with long-term benefits in refractory patients. Pharmacological treatment should be considered in a case-by-case scenario. Cardioneuroablation is a procedure that has been shown to eliminate or significantly reduce the vagal response, leading to symptom relief in up to 75% of patients. Results showed that implementing a definitive pacemaker reduced symptoms in at least one-third of patients. In summary, treatment strategies for VVS are evolving with advances in medical research, allowing for a thorough analysis of each modality to determine its suitability. It is crucial to emphasize that the selection of treatment options should be evaluated by a specialist individually to ensure effective management of the patient’s clinical manifestations. Thus, available interventions have the potential to improve patient’s quality of life significantly.

Keywords: vasovagal syncope, neurocardiogenic syncope, treatment of vasovagal syncope, orthostatic training, pharmacological treatment, tilt training, cardioneuroablation, pacemaker, medical literature review

1. Introduction

Neurocardiogenic vasovagal syndrome (VVS) is a common clinical condition resulting in a transient loss of consciousness and an inability to maintain body posture, with rapid and spontaneous recovery. Its etiology is characterized by being mostly prevalent in women, particularly during youth, and being strongly linked to underlying psychological stressors (Sheldon et al., 2015). The 2015 Heart Rhythm Society Expert Consensus defines VVS as a syncope lacking specific clinical features. It presents a challenge to clinicians and patients, with recurrent episodes of the syndrome potentially resulting in physical injury with serious outcomes (such as increased risk of fractures) and psychological distress. The most common manifestation of VVS is syncope, which may or may not be accompanied by clinical signs such as sweating, weakness, nausea, heat, headache, dizziness, blurred vision, and palpitations (Ali et al., 2021).

Regarding non-invasive forms of treatment, medications can be prescribed to prevent the sudden drop in blood pressure and the resulting syncope (with adequate hydration being an important adjuvant), but there is no specific pharmacotherapeutic approach that acts directly on the condition. Orthostatic training (or tilt training) is a non-pharmacological approach entailing postural training performed via multiple orthostatic sessions (Gajek et al., 2006). Management of the syndrome focuses mainly on behavioral care, such as avoiding and controlling the settings and situations that can trigger it (Abuzainah et al., 2022). In addition, aerobic physical training (APT), a

supervised physical training program, can be employed.

Throughout the 1990s, cardioneuroablation emerged as a potential treatment for patients with vasovagal neurocardiogenic syndrome who do not respond to preventive measures and pharmacological management (Lakkireddy, 2019; Gampa & Upadhyay, 2018). Cardioneuroablation is a catheter ablation procedure that denervates the vagus nerve. This treatment has shown improved safety and efficacy compared to previous invasive approaches, such as pacemaker implantation, with less significant outcomes and high rejection rates among young patients.

In light of technological advances regarding the efficacy of different neurocardiogenic vasovagal syndrome (VVS) treatments, this article aims to comprehensively review the available therapeutic options based on the medical literature. This review analyzes the safety and efficacy of pharmacological and non-pharmacological interventions cited above. Thereafter, it is intended to provide a better understanding of the various treatment options for VVS and their potential benefits.

2. Method

For a literature analysis of the medical literature, priority was given to publications from 2002 to 2022 that address the therapeutic management of vasovagal neurocardiogenic syndrome, which were accessed between late January and early February 2023. The research for scientific articles in bibliographic sources was developed through the PubMed and SciELO databases, using the descriptors “vasovagal syncope”, “neurocardiogenic syncope” and “treatment of vasovagal syncope”. Inclusion criteria were articles consisting of randomized clinical trials and meta-analyses, with scientific texts in English, Portuguese, Chinese, and Spanish. This paper was guided by the research question elaborated from the “PICO” strategy by assessing “P” (population) as those who have the syndrome, “I” (intervention) on the most qualified treatments, “C” (control) as the ways in which the management works and “O” (outcome) on the effectiveness of the treatments observed. In addition, the quality of the research was determined by the Overview Quality Assessment Questionnaire platform. After applying all criteria, only 21 studies were included for further analysis.

3. Results

3.1 Non-pharmacological treatment

3.1.1 Aerobic physical training (APT)

A study on supervised aerobic physical training (APT) found a positive effect in its test group, resulting in a significant increase in maximal oxygen uptake and a reduction in positive tilt tests (Takahagi et al., 2014). Specifically, after a 12-week intervention period, 72.7% of the test group had negative results for syncope at reassessment. These findings suggest that supervised APT may be an effective intervention to increase tolerance time in the orthostatic position.

3.1.2 Tilt training

Tilt training (TTr) is an effective therapeutic method with long-term benefits for patients with refractory symptoms, leading to improved tolerance to orthostasis due to increased vasoconstrictor reserve and a reduction in its variability. A randomized clinical trial involving 28 patients found a reduction in the mean number of vasovagal syncope recurrences (from 4.0 to 3.2 syncopal episodes/year/patient), with a 19% relative decrease in the recurrence rate (Laranjo et al., 2012).

Tilt training is a prevalent treatment, which consists of tilting the body of patients with vasovagal syndrome and can be performed even by the patient at home, leaning on the wall or squatting the body until the tilt angle becomes intolerant. This technique has shown an excellent prognosis in reducing syncope in the daily life of this group of patients, according to several studies in the medical literature (Kisanuki et al., 2022; Jang et al., 2013; Hussain et al., 2021). The only requirements for performing this treatment are: having an accurate diagnosis of the syndrome, educative projects done by medical professionals, and at-home training done by the own patients.

3.2 Pharmacological treatment

The most effective pharmacological treatment for recurrent vasovagal syncope is still elusive (Schleifer & Shen, 2015). Many commonly used drugs have questionable efficacy, pose severe risks of possible adverse effects, and are only considered on a case-by-case basis. A Cochrane review on the pharmacotherapy of vasovagal syncope revealed insufficient evidence to generalize the use of any pharmacological agent to treat VVS (Romme et al., 2011).

3.2.1 Fludrocortisone

While most synthetic corticosteroids have some mineralocorticoid activity, only fludrocortisone is exclusively a mineralocorticoid. As such, this aldosterone analog has received the most attention among potential drugs that may intervene in syncope by modulating blood volume and is likely to be most effective in individuals with a partial response to hydration and salt supplements, as well as in patients with hypotension. In a randomized clinical trial, despite not reaching the pre-established target of a 40% reduction in the incidence of events, daily administration of a 0.2mg dose of the drug demonstrated a significant reduction in the propensity for new episodes of syncope to occur (Sheldon et al., 2015).

3.2.2 β -blockers

Regarding sympathetic nervous system (SNS) activity, vasovagal syncope is believed to be caused by an SNS reaction that causes a rapid spike in catecholamines before the onset of syncope. β -blockers have often been employed to prevent syncope, hoping that they may attenuate the reflex via a decrease in catecholamine release or attenuation of target organ effects.

β -blockers are a heterogeneous group of pharmaceutical substances that act as β -adrenergic receptor antagonists. While specific drugs, such as atenolol and metoprolol, are selective for the β_1 receptor, others are not. Propranolol is a widely studied non-selective β -blocker characterized by its lipophilicity, allowing its passage through the blood-brain barrier. Its ability to exert more expressive effects on the central nervous system than other agents of the same class is well established.

Investigating the use of metoprolol, a multicenter, randomized clinical trial was conducted to evaluate the effects of the medication in preventing vasovagal syncope in 208 patients with a mean age of 42 ± 18 years and a history of 9 syncopal events in 11 years (Sheldon et al., 2006). The results indicate that metoprolol did not provide sufficient efficacy in preventing vasovagal syncope in this population.

In another randomized clinical trial, 30 patients with recurrent vasovagal syncope and positive tilt test were evaluated (Flevari et al., 2002). Patients were randomized to receive propranolol, nadolol, or placebo in sequence, with each treatment lasting three months. The results showed that the central processes of propranolol did not significantly contribute to the therapeutic capacity of β -blockers in vasovagal syncope, suggesting that lipid-soluble and water-soluble drugs may have equivalent therapeutic efficacy. Interestingly, the study revealed that the peripheral processes of nadolol and propranolol are more clinically significant than the central mechanisms. The study findings indicate that lipophilicity and central nervous system action do not significantly improve the therapeutic efficacy of β -blockers.

3.2.3 Selective serotonin reuptake inhibitors (SSRIs)

The components of the Bezold-Jarisch reflex in the autonomic nervous system (ANS) are mainly serotonergic (and also GABAergic) mediated. One hypothesis suggests the possibility of modifying the triggering responses of the reflex by directly or indirectly influencing the neurons involved to reduce the vasodepressor and/or cardioinhibitory action, decreasing the recurrence of syncope. Furthermore, as many of these drugs have anxiolytic qualities, it is possible to infer that they could also benefit the patient by decreasing the anxiety associated with the sudden episodes resulting in loss of consciousness.

Among the medications, a modest but significant impact was seen with fluoxetine and sertraline. Paroxetine, which appears to have the most significant therapeutic potential in its class, was evaluated in a randomized clinical trial that included 68 patients with recurrent syncope, positive tilt test results, and no neuropsychiatric comorbidities (Di Girolamo et al., 1999). The rate of syncope recurrence was 18% in the paroxetine-treated subjects, while in the placebo group, the rate was 53%. Although SSRIs present promising prospects for the treatment of syncope, it is still challenging to determine how much of the potential benefit stems exclusively from their effects on the vasovagal response and how much is due to their anxiolytic properties.

3.3 Cardioneuroablation

Cardioneuroablation is a medical procedure that eliminates or significantly reduces the vagal response, leading to symptom relief in 75% of patients (Carlos Pachon Mateos et al., 2020; Pachon M et al., 2011). No related complications were reported in follow-up studies lasting up to 14 years. Patients who underwent tilt testing within 4 months to one year after the procedure have also reported satisfactory reductions in syncope episodes. This procedure demonstrated promising results in managing symptoms related to autonomic dysfunction. Among the patient inclusion criteria for cardioneuroablation, the main one is the presence of reflex and/or bradyarrhythmia in symptomatic individuals free of existing heart conditions who have not responded to, or have some

contraindication to, non-invasive treatments. A pharmacological test is performed to confirm the reversibility of the condition through the patient's positive response to atropine.

3.4 Permanent Pacemaker (PPM)

The implementation of a definitive pacemaker, as studied in a randomized controlled trial with a population of 511 patients followed for an average of 12 months, demonstrated efficacy in reducing syncope episodes (Brignole et al., 2012). The study found that at least one-third of the population suffering from the syndrome achieved a reduction in their symptoms. However, the effectiveness of the intervention is more limited to mild and moderate cases, with less success in severe cases.

3.5 Closed-Loop Simulation (CLS)

A study published in the Journal of the American College of Cardiology found benefits of a technology provided by a German medical device company called closed-loop simulation (CLS), or closed-loop stimulation, which would be able to nullify the amount of syncope caused by vasovagal neurocardiogenic syndrome for approximately 19 months in a sample of 41 patients (Occhetta et al., 2004). The intervention monitors subtle changes in cellular electrical parameters and thus acts directly on the stimulation of the heart according to electrical stimuli, proving to be effective when indicated.

In summary, the proposed interventions' effectiveness can be found in the table below (Table 2).

Table 2. Assessment of improvement of syndromic neurocardiogenic vagal episodes

Methods	Efficacy	Targeted patients
Permanent pacemaker (PPM) (n = 1)	33% (absolute) and 57% (relative)	Non-severe syndromic adults
Cardioneuroablation (n = 2)	75%	Adults with reflex bradycardia
Aerobic physical training (APT) (n = 1)	72,7%	Adults with a recurring history of syncope
Pharmacological treatment (n = 6)	Reserved on a case-by-case basis	General population
Closed-loop stimulation (CLS) (n = 1)	100%	Severe and recurring syndromic adults
Tilt training (TTr) (n = 4)	19%	General population

4. Conclusion

Given the evaluation studies for the various forms of treatment for neurocardiogenic vasovagal syndrome, a wide variety of options can be identified, which, although heterogeneous, make it possible to visualize an evolution toward improving the prognosis of patients affected by VVS. The high rate of variability between efficacy and recurrence of cases among interventions is partly explained by the multifaceted aspect of the etiology and pathophysiology of this condition, the diversity in clinical manifestations, and the disparities in methodological approaches among the different studies. In conclusion, the management options for vasovagal neurocardiogenic syndrome (VVS) are evolving, and medical advances enable an analysis of the properties of each method to determine their best indications. It is essential to stress that the choice of treatment must be assessed by a specialist physician who has to approach each case individually to ensure the most appropriate and effective treatment for the particular clinical demands of each patient. As a result, the currently available interventions can significantly improve the quality of life of the population affected by this disorder. Further research is needed to understand the underlying mechanisms of vasovagal syncope better and develop more effective treatments for the condition. As a possible future direction for the study of the subject, further elaboration on early detection methods of vasovagal syncope is highly recommended for optimal management. In addition, further research could investigate the potential role of psychological interventions, such as cognitive behavioral therapy, in reducing symptom severity,

syncope recurrence, and improving the quality of life of individuals with VVS.

Regarding the limits of this study, it is essential to realize that some data cannot be directly compared due to the significant level of heterogeneity present among the patients who received therapy for VVS. Also, due to the limited number of studies that were picked for this analysis, there is a potential for bias in the selection process (however, efforts have been made to minimize this risk as much as feasible).

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Data Availability Statement

The data that support the findings of this study are available on request.

Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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Perceived Risk of Breast Cancer in Relation to Precautionary Behavior among Females in Saudi Arabia

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Abstract

Background: For the last two decades, the number of women with breast cancer in Saudi Arabia increased steadily. Risk perceptions or an individual's perceived susceptibility to a threat are a key component of many health behavior change theories. Little is known about relationships between risk perceptions of breast cancer and performing preventive practices.

This descriptive study highlights the risk perception of breast cancer in relation to preventive interventions among females over 18 years old in Riyadh, Saudi Arabia.

Methods: Cross-sectional descriptive correlational design. An online questionnaire was conducted with 500 participants aged 18 years and older. The questionnaire was self-administrated electronic questionnaire designed by using Google Forms and it gated broadcast through social media channels such as WhatsApp and twitter.

Results: The study emphasized a low risk perceptions about breast cancer and performing preventive practices. Positive correlation was found between female's risk perceptions and doing the mammogram screening.

Conclusions: Findings will be helpful to use risk perception of breast cancer in the prediction of women adopting preventive measures.

Keywords: breast cancer; risk perception; preventive measures; Saudi Arabia

1. Introduction

Breast cancer is the second cause of cancer death, with the standardized mortality rate (ASMR) of 12.9 (per 100,000), after lung cancer in the world (Globocan, 2012). Breast cancer with the mortality rate of 12.9 is the first cause of cancer death in women (Pournamdar, Ghoncheh, & Salehiniya, 2016). According to GLOBOCAN estimates, approximately 14.1 million new cancer cases and 8.2 million deaths occurred in 2012 worldwide (Globocan (2012)). However, the lowest incidence rates were in Middle Africa and Eastern Asia (Pournamdar, Ghoncheh, & Salehiniya, 2016).

For the last two decades, the number of women with breast cancer in Saudi Arabia increased steadily. There were 1152 female cases in 2008 in comparison with 1308 in 2009, and 1473 in 2010 (Saggu, Hasibur, Abbas, & Ansari, 2015). Among Saudi patients, there was a significant increase in the number of cases of breast cancer, which occurs at an earlier age compared with Western countries. Continued vigilance, mammographic screening, and patient education are needed to establish early diagnosis and perform optimal treatment (Saggu, Hasibur, Abbas, & Ansari, 2015). Ravichandran and Al-Zahrani (2009) investigated the incidence of female breast cancer in the Gulf Cooperation Council of (GCC) countries in relation to the established reproductive factors. A total of 4480 breast cancer cases were diagnosed in women during 1998- 2002 among GCC country nationals. Breast cancer was the most common malignancy ranging from 16.1% Oman to 35.4% in Bahrain. The age-standardized incidence rate per 100,000 was highest in Bahrain (46.4) (Al Qahtani et al., 2013). Breast Cancer is considered the most implacable malignancy and the leading cause of mortality in the Kingdom of Saudi Arabia. Saudi Arabia is no exception, where cancer of breast is most commonly prevalent. In one of the epidemiological studies conducted, Ravichandran and Al-Zahrani (2009) reported the incidence of breast cancer in Saudi Arabia was 19.8% of all the female cancers detected in the Kingdom. Al-Qahtani et al. (2013) reported that breast cancer as the second most common malignancy in women in Saudi. An earlier report according to Saudi National Cancer Registry reported

an increasing proportion of breast cancer among women of different ages from 10.2% (2000) to 24.3% (2005) (Al Qahtani et al., 2013). The percentage distribution of breast cancer appears to be increasing. There were 1152 female breast cancer cases in 2008 in comparison with 1308 in 2009, and 1473 in 2010. Breast cancer ranked first among females accounting for 27.4% of all newly diagnosed female cancers (5378) in the year 2010 (Saggu, Hasibur, Abbas, & Ansari, 2015).

A woman's risk for breast cancer is higher if she has a mother, sister, or daughter (first-degree relative) or multiple family members on either her mother's or father's side of the family who have had breast cancer. Having a first-degree male relative with breast cancer also raises a woman's risk (Centers for Disease Control and Prevention [CDC], 2017). In 2003, researchers in the Million Women Study (MWS) in the United Kingdom reported that the current use of all types of post-menopausal Hormone Replacement Therapy (HRT) significantly increased the risk of breast cancer (Boyd, Martin, Yaffe, & Minkin, 2011). Again, the risk was greatest among users of estrogen-progestin combination therapy. Other research has confirmed the basic result that use of combined HRT increases risk of breast cancer in post-menopausal women, and that stopping use of the combination pill leads to decreased risk of developing breast cancer. One study in California found that county-wide decreased incidence in breast cancer was highest (22.6%) in counties with the greatest decline in using HRT, intermediate (13.9%) in counties with moderate decreases in HRT use, and smallest (8.8%) in counties with least decline in HRT use (Gray, Rasanayagam, Engel, & Rizzo, 2017). Smoking tobacco is well known to be carcinogenic, not only for breast cancer but for most types of cancer (Globocan, 2012). Its carcinogenic effects are caused by aromatic hydrocarbons contained in tobacco, which, together with genetic polymorphisms in the N-acetyltransferase-2, may influence breast cancer development. It is estimated that tobacco consumption is the cause of 21% of all cancer mortalities worldwide (Dieterich, Stubert, Reimer, Erickson, & Berling, 2014). Obesity, the association between an increased risk of developing postmenopausal breast cancer and body weight was well documented. Adult weight gain and a body fatness and distribution (defined as a body mass index (BMI) above 25 kg/m² and abdominal fatness) were all associated with an increased risk of postmenopausal breast cancer (Howell, Anderson, Clarke, Duffy, & Evans, 2014).

Risk perceptions or an individual's perceived susceptibility to a threat are a key component of many health behavior change theories. Risk perceptions are often targeted in health behavior change interventions, and recent meta-analytic evidence suggests that interventions that successfully engage and change risk perceptions produce subsequent increases in health behaviors (Ferrer & Klein, 2015). According to Rimer and Glanz (2008), positive behavior changes can be obtained by increasing individuals' perceptions of susceptibility or the chances of contracting the disease.

In Saudi Arabia, a study aimed in determining Saudi women knowledge of breast cancer, perception of occurrence, and behavior in relation to breast self-examination. A total of 1000 participants agreed to be involved, out of which 87.7% were females, 7.2% were males and 5.1% had undisclosed gender (Hussein, 2013). The age range for participants was 12-66 years. Out of all participants, 44% did not know that breast cancer is an abnormal growth and 78% failed to recognize its multi-factorial nature, with increased age being the least recognized single risk factor 4.8%. Scores showed that 61.5% had a low level of breast cancer related knowledge. Out of the participants who knew of someone who had breast cancer 73%, 50.1% reported that the disease was discovered at a late stage mainly by chance. Data for Breast Self-Examination (BSE) indicated that 50.1% of female participants >16 years old did not practice BSE, and fear was the main declared perceived reason. Low level of fundamental knowledge of breast cancer and fear to practice breast self-examination was demonstrated by this study (Hussein, 2013). In a study to assess the levels of breast cancer related knowledge among a Northern Saudi population, Alrashidi et al. (2017) noted that there was a great lack of knowledge about several breast cancer risk factors which needs an urgent implementation of health educational programs (Alrashidi et al., 2017). A preventive lifestyle offers valuable information for planning appropriate intervention programs for improving women's health.

In a study to find out the preventive measures of breast cancer, the participants were 10,735, women aged 50-74 years old, only 25% of the respondents reported knowing about breast self-exam. Among these, 57% reported performing a breast self-exam. About 89% of the women reported not having a clinical breast exam in the past year, and 92% of women aged 50-74 years old reported never having a mammogram (Charbel et al., 2015). Women living in Al Sharqia, Saudi Arabia had the highest rate of mammography use. Women who were educated, those who had received a routine medical exam within the last two years, and those who were diagnosed with hypertension were more likely to have had a mammogram in the past two years (Charbel et al., 2015). In Saudi Arabia, studies related to knowledge, attitudes, and practices about breast cancer were conducted. Milaat (2000) revealed a very low level of knowledge of breast cancer and its associated risk factors among female high-school students. However, an older female population from Riyadh was found to be more knowledgeable about breast

cancer. Among 864 women aged 20–50 years old and living in Riyadh, 82% knew about breast self-examination, and 61% knew about mammography. However, 41.2% had performed breast self-examination, and only 18.2% had ever had a mammogram (Milaat, 2000). In Al Hassa governorate, a population-based study found lower rates of mammography, 5.1% among 1,315 women aged 18–65 years old (Milaat, 2000). Another study of teachers in their thirties also showed low levels of breast-cancer-related knowledge, with only 32.4% being aware of breast self-examination (Charbel El Bcheraoui, 2015).

It is imperative to highlight the issues of breast cancer among Saudi Arabian women in relation to their risk perception and preventive behaviors as breast cancer has increased throughout the last decade in Saudi Arabia (Al Qahtani, et al., 2013). It is the goal of this study to investigate the risk perceptions of breast cancer among women in Saudi Arabia and make recommendations for educational programs to increase the knowledge of breast cancer risks to decrease the incidence of breast cancer among the target population. According to Schwarzer (2011), risk perception represents the most obvious motivation for overcoming a risk behavior. Investigating the risk perceptions of breast cancer is a key predictor of Saudi Arabian women's likelihood of performing screening mammogram in order to prevent breast cancer. Breast cancer risk factor awareness and risk perception are considered to be prerequisites for adopting preventive behaviors. The present study will play an important role in providing a research-based framework for lowering risks for breast cancer based on the identified perceptions. Furthermore, the results of this study will support greater awareness and prevention of breast cancer, and create targeted areas for future health promotion and education efforts. Findings of the study will be helpful to use risk perception of breast cancer in the prediction of Saudi Arabian women adopting preventive measures.

2. Methods

The purpose of this study was to investigate the risk perceptions of breast cancer in relation to the adoption of health-protective behaviors among women in Saudi Arabia.

This study included the research question: What will be the risk perceptions of breast cancer among women who are over 18 years old in Riyadh, Saudi Arabia?

2.1 Objectives of the Study

- To identify women's perception about breast cancer risks.
- To explore the relation between age and the perception of risk of breast cancer.
- To explore the relation between age and taking breast cancer preventive behaviors.
- To investigate if there is an association between perception of risk of breast cancer and taking preventive behaviors such as monthly breast self-exam and mammogram screening.

2.2 Research Design

This study used a cross-sectional descriptive correlational design to explore the relationship between perceived risk, the demographic variables and taking preventive behaviors. The survey was used as the research tool to measure participants' risk perceptions of breast cancer. An online survey was conducted with 500 participants aged 18 years and older. The survey included information about demographic characteristics, subject's risk perception of breast cancer, and breast cancer preventive behaviors. A total of 500 participants completed the online survey. All participants were living in Riyadh, Saudi Arabia. Study variables included demographic characteristics, (age, marital, education level, occupation, and family history), risk perception of breast cancer and participants breast cancer preventive behaviors.

2.3 Data Collection Methods and Instruments

Approval for conducting this study was obtained through the College of applied Medical Sciences Institutional Review Board (IRB). All answers have been dealt with confidentially and have been used for research purpose only. The questionnaire was self-administrated electronic questionnaire designed by using Google Forms and it gated broadcast through social media channels such as WhatsApp and twitter. Data were collected from 26 of March 2018 until 5th of April 2018. An online questionnaire has been developed to include three sections. First section is demographic characteristics, (age, marital status, education level, occupation, and family history). The second section was the risk perception of breast cancer; it was measured by asking three questions adopted by (Levy, Shea, Williams, Quistberg, & Armstrong, 2006). First question asked the participants what do they think their chance of developing breast cancer in their lifetime in percentage from 0% to more than 50%. Second question asked the participants how do they rate their chance of developing breast cancer (very low, moderately low, neither low nor high, moderately high, very high). Last question was about how they think their chance of developing breast cancer compares to the average women in same age (very much lower, much lower, about the

same, much higher, very much higher). The last section included questions in relation to breast cancer preventive behaviors measured by asking if the participants had performed mammogram, and breast self-examination, if their answered yes, they were asked to indicate how often (weekly, monthly, occasionally or rarely).

3. Results

A total of 500 women were included in the study. A total of 500 surveys were usable for data analysis. None of the survey were excluded because all the data was completed through an online questionnaire that works by the mechanism of non- sending the questionnaire unless all answers are completed. The survey was designed by using Google Forms and was distributed through social media channels such as WhatsApp, Twitter, Snapchat. Data were prepared for analysis in SPSS. Descriptive statistics, frequencies, and Pearson Correlation were used for statistical analyses. Demographic background of the study samples (n = 500) are presented in Table 1.

Table 1. Demographic Characteristics of Participants at Baseline (N =500)

Age	Frequency	Percent
18-29	197	39.4
30-49	226	45.2
50-65	77	15.4
Total	500	100.0
Social status	Frequency	Percent
single	156	31.2
married	326	65.2
divorced	11	2.2
widow	7	1.4
Total	500	100.0
Nationality	Frequency	Percent
Saudi	483	96.6
not Saudi	17	3.4
Total	500	100.0
Education level	Frequency	Percent
elementary	6	1.2
middle school	16	3.2
high school	111	22.2
academic	367	73.4
Total	500	100.0
Occupation	Frequency	Percent
house wife	143	28.6
employee	166	33.2
student	135	27.0
free business	8	1.6
unemployed	48	9.6
Total	500	100.0
Family history	Frequency	Percent
none	407	81.4
first degree		
relatives	30	6.0
second degree relatives	59	11.8
first and second degree relatives	4	.8
Total	500	100.0

Ages ranged from 18 to 65 years. As seen in Table 1, almost half of the participants were aged 30-49 years. Most of the participants were Saudis. Majority of the participants were married, followed by single, divorced, and widowed. Of this sample, majority of the participants do not have family history of breast cancer. Most of the participants (69.5%) indicated that they have a very low chance to develop breast cancer in their lives. The majority of participants rate their chance of developing breast cancer between 0-10%. The majority of participants reported that their chance in developing breast cancer is lower than other women in their average age. The study revealed that as the age increases, female's expectation of their chance of developing breast cancer decreases.

Table 2. Correlation between Age and Females Perception of Developing Breast Cancer

Spearman's rho		Age	How much do you think is your chance of developing breast cancer during your life?
Age	Correlation Coefficient	1.000	-.075
	Sig. (2-tailed)		.094
	N	500	500
How much do you think is your chance of developing breast cancer during your life?	Correlation Coefficient	-.075	1.000
	Sig. (2-tailed)	.094	.
	N	500	500

As shown in Table 2, negative correlation (-.075) was found between age and risk perception of developing breast cancer, but it is not significant as the P value is more than 0.05. As the age increases, females risk perception decreases. Negative correlation (-.060) was found between age and females expectation of developing breast cancer, but it is not significant as the P value is more than 0.05. As the age increases, female's expectation of developing breast cancer decreases. Significance negative correlation (-.156) was found between age and females' expectation of their chance of developing breast cancer compared to other women in their average age as the P value is less than 0.05. Significance positive correlation (.384) was found between age and doing mammogram screening as the P value is less than 0.05. As the age increases, doing mammogram increases. Positive correlation (.029) was found between female's risk perceptions and doing the mammogram screening, however the correlation was not significant as the P value is more than 0.05.

4. Discussion

The study conducted to measure the risk perception of breast cancer among females over 18 years old in Riyadh, Saudi Arabia. The total female response rate was 100%. According to the results, most of the participants aged from 30-49 (45.2%) which may be due that the fact that most of online users in this group age. The majority of the participants were married (65.2%) and have the Saudi nationality (96.6%). Most of the participants were having the an academic degree that is due to the fact that the survey was spread through all college groups, and 33% from them were employees, 81% from the participants doesn't have any family history of breast cancer. The study showed that having a second degree relative with breast cancer is higher (11.8%) than having a first degree relative with breast cancer (6%). The study revealed a negative correlation between age and risk perception of developing breast cancer, but not statistically significant. As the age increases, females risk perception decreases. Responses given by the participants in this study showed a negative correlation between age and female expectation of their chance of developing breast cancer compared to other women in their average age. The correlation is statistically significant with a significance level of $p < 0.005$. According to the statistics, a negative correlation was found between age and doing breast self-exam. The correlation is statically significant at $p < 0.005$. The study indicated that majority of the participants had never had a mammogram in their life (78.4%). To answer the research question, what will be the risk perceptions of breast cancer among women who are over 18 years old in Riyadh, Saudi Arabia, participants were asked to answer questions related to their risk perceptions of the disease. Most of the participants (69.5%) believed that they have a very low chance to develop breast cancer in their lives. A comparison question was asked to measure the participants' perception of developing breast cancer compared of women to their age. Most of the participants reported that their chance will be much less than them (49.3%), followed by, the other less than them (27.5%), equal to them (19%), higher than them (3.8%), and much more than them (0.4%). The major findings of this study showed a negative correlation between risk perception of breast

cancer and age, suggesting that as people get older, their perception of developing breast cancer decrease. It seems that older women have a low perception of developing breast cancer. The study examined if there is an association between risk perception of breast cancer and taking preventive behaviors such as monthly breast self-exam and mammogram screening. According to the results, most women never did mammogram test in their lives (78.4%), some of them did it 1-3 times (18%), and only 18 women performed it more than 3 times (3.6%). It is possible that, due to that most of the participants reported having no family history of breast cancer. There was a positive correlation between risk perceptions and doing the mammogram screening, as the perception increases, taking preventive behaviors increases. However, the correlation was not statistically significant. Studies showed that performing screening test lowers incidence rate for advanced-stage breast cancer (Sankaranarayanan, 2013). In this study, most of the participants perform monthly breast self-examination (53.7%), we asked this group of participants how many times they perform the test, most of them perform it rarely (47.4%), those how perform it weekly 9%, monthly 32.2%, and yearly 11.5%. Correspondingly, previous research has indicated the number of mortality rates of breast cancer are decreasing this is due to early detection of mammography screening (Colditz, Bohlke, & Berkey, 2014).

The findings of this study pointed out the low perceived risk and low screening practices among females over 18 years old in Riyadh Saudi Arabia. This is consistent with other findings from previous studies, where women showed low knowledge, perceptions and performing preventive practices (screening and breast self-examination) (Hussein, 2013; Alrashidi et al., 2017). Consistency was noted in this study, as low risk perception was accompanied by a low preventive measure. As reported by Glanz, Rimer, & Viswanath (2008), people are more likely to engage in healthier behaviors if they perceive the risk of not doing so. That means perceived risk of breast cancer motivates people to uptake preventive practices and to perform screening to prevent breast cancer. The current risk perceptions and preventive behaviors of the sample could indicate a likelihood of an increased risk of breast cancer. It is therefore, important to promote awareness of the risks of breast cancer and the importance to uptake preventive measures, so that lower risk perception does not translate into lower preventive behavior. There is a need to address risk perceptions issues in order to increase the uptake of preventive measures. That can best be done by educating the women about the benefits of early screening, early detection, and its association with lower incidence and mortality rates from breast cancer.

This study has several implications for the development of educational interventions to motivate women to perform preventive practices. This study has shown that the study participants are not demonstrating healthy preventive measures to prevent breast cancer. Therefore, more programs with education intervention strategies to teach women about the benefits of early detection and severity of the disease may be warranted. Health care providers, such as health educators could help to promote effective adoption of preventive behaviors. The primary method of prevention involving risk perception changes and screening practices motivation should be targeted to these women, as their levels of risk perceptions of breast cancer and their performance of preventive practices were low. This study has implications for the Health Education Department, Ministry of Health in Saudi Arabia and for primary health care centers and clinics in Saudi Arabia. Its findings may help these institutions to promote an intervention that targets behavioral change and to educate and prompt the target population to adopt preventive measures that reduce the risk of breast cancer.

5. Conclusion

This study examined perception of risk to breast cancer of female in Saudi Arabia. The study offers new insights applicable to health institutions and health professional practice. Findings from the current study can inform health educators about Saudi Arabian women's risk perception of breast cancer. These findings can help health educators to design appropriate programs, awareness messages, and community campaigns to increase the knowledge and health beliefs about breast cancer and its consequences. Low awareness about the importance of preventive measures were linked to low performance of breast self-examination and mammography test. Women need to be educated about the benefits of breast cancer screening. Health education, counseling, outreach programs, and community-based interventions are recommended to improve the uptake of mammogram test in Saudi Arabia. The results of this study indicate that continued research in this area is warranted. Future research could, for example, determine factors affecting breast cancer screening test and how to overcome the barriers. It is important to study how perceptions are formed among women and why they do not practice behaviors that could reduce their chance of developing breast cancer and promote overall wellness and optimal health.

Ethical Considerations

None.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author.

Competing Interests Statement

The author declares that there are no competing or potential conflicts of interest.

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The Effect of Individual Preferences on Precautionary Behaviors in Vaccine Taking, Saving, and Physical Activity

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Abstract

The COVID-19 pandemic has underscored the importance of how people react behaviorally to external threats. Precautionary behavioral responses to COVID-19 become apparent. In addition, individual risk and time preferences are related to economic behaviors under uncertainty and health-related behaviors. This study aims to determine whether and how time and risk choices influence precautionary behaviors in vaccine-taking, saving, and physical activity during the coronavirus lockdown. We conducted a cross-sectional study utilizing an online survey, which included a sample of 1016 individuals aged 18 to 60 residing and working in Shanghai. We use logistic regressions to estimate. We have three findings. First, risk-taking and future-oriented individuals are more likely to get vaccinated. Second, future-oriented ones are more inclined to exercise at home via digital media during the lockdown. Third, neither risk preference nor time preference is predictive of precautionary saving. This work aids the literature by documenting time and risk preferences influencing health-related behaviors and life well-being during the lockdown. The conclusions have practical implications from a policy perspective.

Keywords: time preference; risk preference; the willingness to take vaccines; precautionary saving; home-based exercise via digital media

1. Introduction

The COVID-19 pandemic has highlighted the significance of an individual's behavioral reaction to external threats, such as a severe infectious disease outbreak (Frías-Armenta, Corral-Frías, Corral-Verdugo, & Lucas, 2021). Roughly three years following public efforts to prevent this virus from spreading, More than 6.6 million fatalities and 658 million documented cases have been reported globally. Many precautionary behavioral responses to COVID-19 appear. For example, taking vaccines (ElBagoury et al., 2021), precautionary saving (Zhang, Lu, & Zhong, 2022), and keeping physical exercise at home (Da Silveira, da Silva Fagundes, Bizuti, Starck, Rossi, & de Resende E Silva, 2021). These responses reflect individuals' precautionary principle (Isaacs, 2021) and their aim to maintain their well-being (Corral-Verdugo, Corral-Frías, Frías-Armenta, Lucas, & Peña-Torres, 2021) in this uncertain context (Koffman, Gross, Etkind, & Selman, 2020).

These precautionary behaviors can bring observable benefits. Particularly, accepting vaccines can boost immunity and reduce the medium-term risk of severe disease (Krause et al., 2021). In addition, COVID-induced precautionary saving can increase the saving buffer when facing possible adverse changes in future income or employment prospects due to the pandemic threat (Immordino, Jappelli, Oliviero, & Zazzaro, 2022). Furthermore, physical exercise at home can maintain good health (Lavie, Ozemek, Carbone, Katzmarzyk, & Blair, 2019) to offset the adverse outcomes of certain diseases (Ozemek, Lavie, & Rognmo, 2019). It is also a therapeutic approach to combat the mental and physical repercussions of COVID-19 quarantine, such as preventing self-worth and cognitive impairment or deterioration (Jiménez-Pavón, Carbonell-Baeza, & Lavie, 2020).

Therefore, studying and tracking predictors contributing to individual heterogeneity in precautionary behaviors during the pandemic becomes essential. Risk preference refers to an individual's willingness to take on risk or uncertainty when making financial or other resource decisions. Time preference, on the other hand, deals with how individuals value present consumption or benefits compared to future consumption or benefits. They can

significantly influence precautionary behaviors, particularly in financial decision-making and saving for unforeseen events (Herberholz, 2020). However, existing literature provides limited insights into the potential impact of time and risk preferences on precautionary behaviors like vaccine-taking, saving, physical activity, or exercise during the pandemic.

This research contributes to the expanding body of empirical evidence regarding the effect of individual preferences on these precautionary behaviors and gives possible interpretations. Specifically, We carried out a cross-sectional study through an online survey, encompassing 1016 Shanghai residents aged between 18 and 60, all living and working in the city. Logistic regression is used to estimate and test hypotheses. Our results underline the following points. First, risk-taking and future-oriented people are more likely to accept vaccines. Second, future-oriented people are more likely to keep physical exercise via digital media during the lockdown period. Third, neither risk preference nor time preference predicts precautionary saving. Our results have implications for public health authorities and fitness clubs and gyms.

2. Literature Review

2.1 Time Preference, Risk Preference, and The Inclination to Receive the COVID Vaccine

The extent of the COVID-19 vaccine rollout differs among countries. (Peters, 2022), and it is compulsory to understand the factors that influence the vaccination rate (Hudson & Montelpare, 2021). Macroscopic predictors comprise financial affordability (Wouters et al., 2021), vaccine supply (Alam, Ahmed, Ali, Sarker, & Kabir, 2021), storage capacity (Sun et al., 2022), vaccine production (Feinmann, 2021), distributing capability (Mills & Salisbury, 2021), and public misperception (Mac, Muscat, Ayre, Patel, & McCaffery, 2021). Microscopic factors include socio-demographic factors, such as age (Volkman, Hokeness, Morse, Viens, & Dickie, 2021), income and dependent children (Wu et al., 2008), education (Carpiano, Polonijo, Gilbert, Cantin, & Dubé, 2019), rurality (Wagner et al., 2021), and psychological factors, such as mistrust in vaccine safety, conspiracy beliefs, susceptibility to infection (Troiano & Nardi, 2021), individual preferences (Cawley & Ruhm, 2011; Tsutsui, Benzion, Shahrabani, & Din, 2010), as well as other factors, such as health literacy (Lorini et al., 2018), cultural factors (Agarwal et al., 2021).

Authorities have made substantial efforts to mitigate and control the transmission of the COVID-19 virus and its variants (Yang et al., 2021). The collective inclination to take the COVID-19 vaccine was at a rate of 88.9% in 2020. As mentioned above, identifying psychological structures that promote or hinder vaccination is important (Gerretsen et al., 2021; Nazlı, Yılmaz, Sevindik, & Deniz Özturan, 2022). Notably, Our primary goal is to ascertain whether an individual's time and risk preferences can be used to predict their inclination to receive the COVID-19 vaccine. One reason is that these individual preferences affect health-related decisions, including vaccines (Cawley & Ruhm, 2011; Tsutsui et al., 2010). Additionally, time preference plays a role in shaping an individual's intention to get vaccinated because people would like to get immunizations in the future by bearing the present costs. The third reason is that risk averters tend to feel confused between infectious risk due to no vaccination and the side effects of the vaccines (Okamoto, Kamimura, & Komamura, 2022).

Time preference provides insights into the trade-offs people make between immediate and future outcomes and informs strategies for improving long-term decision-making, for instance, taking vaccines against diseases. The relationship between time preference and vaccine uptake is controversial in the literature. A US study reports considering future consequences is not relevant to H1N1 vaccine uptake based on a survey of 411 university students (Nan & Kim, 2014). Nevertheless, other papers reported similar findings in that time preference influences the willingness to take the vaccine. For example, in a representative German dataset (including 1778 randomly selected respondents), future-oriented people are more likely to get the flu vaccine (Nuscheler & Roeder, 2016). People with smaller time discount rates are more likely to accept HBV (Hepatitis B Virus Vaccination) vaccination (Guo, Wang, Nicholas, Maitland, & Zhu, 2020). Future-oriented French individuals tend to get the COVID-19 vaccine (Guillon & Kergall, 2021). Okamoto et al. (2022) mention that time preference can predict COVID-19 vaccine hesitancy based on the Japanese sample.

Therefore, previous studies have provided evidence of the relationship between time preference and the willingness to take the vaccine. Meanwhile, the evidence on whether time preference predicts the desire to take a vaccine against COVID-19 is limited. This study proposes to see whether time choice influences the willingness to get the COVID-19 vaccine in the Chinese sample, which seeks to expand the existing body of literature by presenting fresh empirical findings and paving the way for possible interventions to tackle vaccine hesitancy. The first hypothesis can be expressed as:

Hypothesis 1: Time preference positively correlates with the willingness to get a vaccine against COVID-19.

Risk preference reflects how much they prefer to avoid risk and opt for safer, more predictable outcomes. Does risk preference influence the acceptance of COVID-19 vaccination? In the literature, the majority of relevant papers suggest there is such a relationship. For instance, risk perception triggers preventative action for influenza, like taking vaccine (Chapman & Coups, 2006); the perception of risk increases the acceptance of an H1N1 vaccine (Ibuka, Chapman, Meyers, Li, & Galvani, 2010) and predicts the acceptance of a COVID-19 vaccine (Caserotti et al., 2021; Guillon & Kergall, 2021). Given that risk perception and preference differ (Meraner & Finger, 2019), more direct evidence is that Trueblood, Sussman, and O'Leary (2022) state monetary risk preferences correlate to a COVID-19 vaccine's take-up based on a US sample.

Hence, the evidence on whether risk preference predicts the willingness to take a vaccine against COVID-19 is limited. This research seeks to enhance the existing body of literature by introducing novel empirical evidence concerning the influence of risk preference on the willingness of Chinese participants to receive the COVID-19 vaccine, and it also aims to propose interventions aimed at reducing vaccine hesitancy and increasing vaccine acceptance. The second hypothesis can be described as follows:

Hypothesis 2: There is a positive correlation between risk preference and the inclination to receive a COVID-19 vaccine.

2.2 Time Preference, Risk Preference, and Precautionary Saving

Both saving and consumption play pivotal roles in individual financial choices, potentially impacting economic development and growth (Jin, Zhao, Song, & Zhao, 2021). In the Permanent Income model (Christiano, Eichenbaum, & Marshall, 1987), an outcome of a future decrease in income will lead to an increase in savings. Therefore, savings can optimally allocate lifetime income to consumption (Lugilde, Bande, & Riveiro, 2019). In an uncertain context, a positive extra saving is generated, called "precautionary saving." Recently, the COVID-19 pandemic threatened our future income and has caused an economic shock in a short time that is exacerbated by uncertainty concerning its length and depth (Miescu & Rossi, 2021). This cumulative uncertainty has influenced both companies and individuals. They have subsequently diminished investment, spending, and consumption (Vergara & Bonilla, 2021) because individuals often allocate their household savings to bolster their financial resilience in the face of unforeseen emergencies, such as contagious diseases (Baiardi, Magnani, & Menegatti, 2020). Hence, COVID-induced precautionary saving becomes necessary (Dossche & Zlatanov, 2021; Zhang et al., 2022).

Precautionary saving is also influenced by personal characteristics and the environment (Lugilde et al., 2019), such as current income (Menegatti, 2010), family composition (Banks, Blundell, & Brugiavini, 2001), age, gender, race, marital status, health (Deidda, 2013), education (Mishra, Uematsu, & Fannin, 2013), unemployment episodes (Lusardi, 1997). We propose investigating the relationship between psychological factors and precautionary saving in the context of the COVID-19 pandemic.

Essential preferences, such as altruism, risk preferences, reciprocity, time preference, or trust, form the groundwork of choice theories and direct human behavior (Falk & Hermlé, 2018). Time preference refers to preferences over intertemporal trade-offs or the timing of rewards (Cohen, Ericson, Laibson, & White, 2020). Given the significance of time preferences in decision-making (De Marchi, Cavaliere, & Banterle, 2021), some empirical literature documented the relationship between time preference and saving behavior. For example, Saving in advance for retirement is inspired by the need to increase consumption decades in the future. Time discounting predicts such saving behavior (Finke & Huston, 2013). In addition, in Korea, when individuals are future-oriented (presented-oriented), they save more (less) by reducing (increasing) consumption, indicating that saving behavior can be well interpreted by time preference (Choi & Han, 2018). However, little is known about the association between time preference and precautionary saving during the pandemic. The third hypothesis is as follows:

Hypothesis 3: Time preference increases the probability of saving in advance.

We differ in our willingness to take risks. Important decisions about health, financial affairs, and relationships often raise the question of how much trouble an individual bears to take (Arslan et al., 2020). Particularly, in the literature, risk aversion is a sufficient condition for the existence of precautionary saving (Menegatti, 2001). In addition, Bommier and Grand (2019) report that in the context of binding borrowing constraints and income uncertainty, based on the two assumptions of preference monotonicity and a stochastically monotone income process, risk aversion is positively associated with savings. One interpretation is that when uncertainty exists, precautionary saving occurs (Vergara & Bonilla, 2021). Risk-averse individuals' uncertainty about future income is identified as impaired, diminishing their well-being. Subsequently, these people would use "precautionary

saving” to reallocate current wealth to the future, reducing their pain due to uncertainty and increasing their well-being (Eeckhoudt, Schlesinger, & Tsetlin, 2009). Given the current uncertainty stemming from the COVID-19 pandemic, this study aims to provide empirical evidence on risk preference influencing precautionary saving during the pandemic. The fourth hypothesis is as follows:

Hypothesis 4: Risk preference reduces the probability of saving in advance.

2.3 Time Preference, Risk Preference, and Home-Based Exercise via Digital Media

The existing global pandemic of COVID-19 implemented strict emergency procedures and restrictions, such as quarantines, home confinement, and the complete shutdown of cities, to prevent virus dissemination (Amatriain-Fernández, Murillo-Rodríguez, Gronwald, Machado, & Budde, 2020). These changes may cause mental and physical health problems in quarantined individuals and healthcare employees (Brooks et al., 2020). Physical exercise is an imperative intervention (Amatriain-Fernández et al., 2020) to reduce the impacts of this pandemic on physical health (Ghram et al., 2021). The advantages of keeping physical exercise during the pandemic are vast. First, physical exercise positively impacts mental disorders (Zschucke, Gaudlitz, & Ströhle, 2013) and related problems, such as frustration and boredom (Foye, Li, Birken, Parle, & Simpson, 2020). Second, physical exercises enhance one’s chronic immune system (Nieman & Wentz, 2019; Peake, 2020). Routine and systematic exercises work in the prevention and complementary treatment of virus-related infections, such as COVID-19 (Halabchi, Ahmadinejad, & Selk-Ghaffari, 2020; Wu et al., 2020; Zbinden-Foncea, Francaux, Deldicque, & Hawley, 2020). In addition, it is positively associated with the cure rate and negatively associated with morbidity and mortality (Lin, Hu, Guo, & Huang, 2022). Therefore, it tends to be a crucial factor in the protection power of the immune system when facing the threat of COVID-19 (Scartoni et al., 2020; Da Silveira et al., 2021).

Since physical activity and exercise significantly influence our well-being during the pandemic (de Abreu et al., 2022), it is worthwhile to find physical exercise barriers and enablers (Granger et al., 2017). In the literature, using the COM-B model (Michie, Van Stralen, & West, 2011; Granger et al., 2017), factors that predict physical exercise are attributed to 1) capability, including physical and psychological factors, such as comorbidities, mood, confusion about physical activity, introversion, feel overwhelmed; 2) opportunity, such as time and convenience, weather, access to services, social support (Blake, Stanulewicz, & McGill, 2017); 3) motivation, such as fear to physical activity, personal, self-efficacy (Rodrigues, Teixeira, Neiva, Cid, & Monteiro, 2020). Therefore, identifying factors that promote physical exercise is valuable, especially in the context of the pandemic (León-Zarceño, Moreno-Tenas, Boix Vilella, García-Naveira, & Serrano-Rosa, 2021). Particularly, the third objective of the present paper is to investigate the effect of individual time preference and risk preference on physical exercise. The main reason is that personal risk and time preferences influence economic behaviors under uncertainty and health behaviors (Herberholz, 2020), such as overeating and obesity (Zhang & Rashad, 2008), adherence to physician advice on health behavior change (van Der Pol, Hennessy, & Manns, 2017), vaccination (Tsutsui, Benzion, & Shahrabani, 2012), etc.

Time preference predicts general human capital investments, of which health maintenance habits are one (Bradford, 2009). One underlying mechanism to explain is that individuals with higher discounting rates (who are present-oriented) are less inclined to spend time and effort developing healthy habits with upfront costs to have better future health (Norrgren, 2022). In addition, physical exercise is conceptualized as a habitual health behavior (Aarts, Paulussen, & Schaalma, 1997). Therefore, we expect that time preference is associated with physical exercise. Furthermore, during the COVID-19 pandemic lockdown, home confinement applies, and people are forced to stay home. Consequently, home-based physical activity has become an alternative to outdoor sports (Hammami, Harrabi, Mohr, & Krstrup, 2022). Given that physical exercise based on digital media has become prevalent in many countries (Ballin et al., 2020; Parker et al., 2021; Mutz, Müller, & Reimers, 2021), our objective is to make a contribution to the existing literature by examining the following hypothesis, which is as follows:

Hypothesis 5: time preference is positively associated with home-based physical exercise via digital media during the pandemic lockdown.

Risk preference refers to a stable psychological trait (Schildberg-Hörisch, 2018), which explains individual differences in risk appetite and their decision to participate in behaviors. These behaviors could be investing in stock markets, committing crimes, or consuming drugs, which include a trade-off between potential costs and benefits associated with risk and uncertainty (Mata, Frey, Richter, Schupp, & Hertwig, 2018). The empirical findings regarding the connection between risk preference and health-related behavior are subject to debate. On one side, risk aversion is negatively associated with unhealthy behaviors, such as smoking (Jusot & Khlat, 2013), heavy drinking (Dave & Saffer, 2008), being overweight, and not using a seat belt (Anderson & Mellor, 2008;

Ferrer & Klein, 2015). In contrast, some studies claim no evidence to support the relationship between risk preference and health behavior (Conell-Price & Jamison, 2015; van der Pol et al., 2017). More recently, the relationship between risk preference and sports and physical activity (Kalashi, Eydi, Abbasi, & Foroughi, 2022; List, List, Ramirez, & Samek, 2022) has been documented. One potential explanation for this correlation is that individuals with a higher inclination for risk-taking may emphasize the health-related benefits of strenuous exercise and less on the possibility of injury. Given the fact that digital media built a new scene for socialization and sports practice during the COVID-19 pandemic (Mazza, 2021), we aim to extend the literature by evaluating the association between risk preference and doing home-based physical exercise via digital media, which is detailed as follows:

Hypothesis 6: more risk-seeking individuals are more likely to exercise at home via digital media.

3. Method

3.1 Survey and Eligibility Criteria

This cross-sectional study took place in Shanghai following the lifting of the lockdown measures. We launched an online survey using the WJX technology platform, which provides services for distributing the survey and collecting data and has received recognition from reputable journals.

Study invitations were sent to potential participants in the pre-registered panel in Shanghai. Before participation, all survey respondents were aware of the study's purpose before signing a digital consent form. Afterward, They accessed the link to complete the questionnaire. The research proposal received approval from the Ethics Committee affiliated with the authors' institution.

Individuals between 18 and 60 who were employed and living in Shanghai during the lockdown were included for further analysis. In this survey, a total of 1325 questionnaires were gathered, and 1016 of them were deemed valid. 309 questionnaires were excluded from the study due to missing data, speedy responses, obvious fictitious entries, and inconsistencies. Hence, the questionnaire's validity rate stood at 76.68%.

All questions were translated into Chinese from the original English. Chinese-speaking researchers evaluated these questions to assess and before starting the study to determine and enhance reliability and validity.

3.2 Data Gathering and Measurement

The questionnaire collected data on 1) socio-demographic characteristics, encompassing gender, age, marital status, the presence of children under 12 years old, educational attainment, annual household income, and income stability; 2) risk preference and time preference; and 3) participants' intent to receive the COVID-19 vaccine, engagement in home-based physical activity through digital media, and precautionary saving habits.

Time preference. We choose a combination of intertemporal behaviors to measure time preference, as proposed by Finke and Huston (2013). Participants were subsequently queried about their behavior in seven areas, including wearing a seatbelt while driving, smoking, consuming wine, utilizing nutrition labels when grocery shopping, participating in vigorous physical exercise, engaging in unprotected sexual activity, and making dietary choices. Each question employs a five-point Likert scale from "never" to "always." For positive behaviors, for example, using nutrition labels when shopping for food, we coded 1 (5) for those who never (always) look at nutrition labels when purchasing food. In contrast, for negative behaviors, for instance, smoking, we coded 1 for those who smoke almost daily and 5 for those who never smoke. Therefore, this additive scale varies between 7 and 35, with a higher score indicating a higher possibility of delaying fulfillment and focusing on future goal attainment.

Risk preference. We employ a simple question to assess risk attitudes in a broad context, as Dohmen et al. (2011) proposed. The participants were requested to evaluate their inclination to engage in risky behavior: "How do you see yourself: are you generally fully prepared to take risks, or do you try to avoid them? Please tick a box on the scale, where the value 0 means 'not at all willing to take risks' and the value 10 means: 'very willing to take risks.'"

Willingness to get vaccinated. The respondent was asked, "Do you plan to get all doses of a coronavirus vaccine when available?" This measurement is introduced by Qin, Wang, and Ni (2021). A value of 1 is assigned to this variable when the respondent answers 'yes'; otherwise, we assign 0.

Precautionary saving. A straightforward question is given to the respondent, "After experiencing the lockdown in Shanghai, have you or your household increased the amount you save for coping with unforeseen events, such as unemployment, health, or other emergencies?" which is proposed by Immordino et al. (2022). It is set to 1 if the respondent answered 'yes'; otherwise, it is 0.

Exercising at home via digital media. We measure it with a question Mutz et al. (2021) suggested, "Please think of

the last six months: Have you used videos, online programs, or other digital media for sports activities at home?" We would assign a value of 1 to it in case respondents answered 'yes'; otherwise, it would be 0.

Socio-demographic attributes. They are control variables. We incorporate them to address endogeneity issues and prevent skewed estimates. The *Age* variable consists of five consecutive sub-groups: 24 or younger (1), 25-34 (2), 35-44 (3), 45-54 (4), and 55 or older (5). *Annual household income* is divided into five sequential sub-groups, with the following codes: "less than 20,000 (1), 20,000 – 50,000 (2), 50,001-100,000 (3), 100,001 - 200,000 (4), and 200,001 and above (5)." The *Male* variable is binary, taking a value of 1 if the respondent is male and 0 otherwise. The *Marital status* variable is set to 1 if the respondent is married and 0 otherwise. The *Higher education* variable is binary, assigned a value of 1 if the participant possesses higher education and 0 if not. The variable *Children under 12* is binary, with a value of 1 representing the presence of a child under 12 years old in the respondent's household and 0 otherwise.

Furthermore, we introduce *income risk* as a dummy variable because it influences the probability of augmenting savings and decreasing consumption (Immordino et al., 2022). It is assigned a value of 1 if the respondent selects (1), (2), or (3) from the question, "During the Shanghai lockdown, which sentences best describe your work situation? (1) I have lost my job; (2) I still have a job but expect to lose it in the next six months; (3) I still have a job but am working fewer hours than before the crisis; (4) My job position has remained stable; (5) I have found a (first or new) job; (6) I do not work and am not working before the crisis." Otherwise, it equals 0.

3.3 Econometrics Model

A logistic regression model is used to investigate the effect of time and risk preferences on willingness to get vaccinated. The advantages of logistic regression are as follows: firstly, it is unnecessary to assume either the outcome variable or the predictor variables follow a normal distribution; secondly, the associated error terms could be either normally distributed or not. Thirdly, we do not assume linear relationships between the independent and dependent variables.

The provided model below aims to explore the connection between time preference and the inclination to receive vaccination (Hypothesis 1) and the association between risk preference and the intent to receive the vaccine (Hypothesis 2):

$$\begin{aligned} \text{Willingness to take COVID vaccines}_i \\ = \beta_0 + \beta_1(\text{Time preference}_i) + \beta_2(\text{Risk preference}_i) + \sum_{k=7}^k \beta_k X_{ik} \\ + \epsilon_i \end{aligned} \quad (1)$$

where X_{ik} is a set of covariates for individual i , comprising age, gender, marital status, higher education attainment, annual household income, presence of children under 12, and income risk. ϵ_i represents the residual term.

The following model is crafted to explore the relationship between time discounting and precautionary saving (Hypothesis 3) and the association between risk preference and precautionary saving (Hypothesis 4):

$$\text{Precautionary saving}_i = \beta_0 + \beta_1(\text{Time preference}_i) + \beta_2(\text{Risk preference}_i) + \sum_{k=7}^k \beta_k X_{ik} + \epsilon_i \quad (2)$$

where X_{ik} is a set of covariates for individual i , as the same as in Equation (1). ϵ_i represents the residual term.

The third model aims to assess the link between time preference and engaging in home-based exercise through digital media (Hypothesis 5) and the relationship between risk preference and digital sports (Hypothesis 6):

$$\text{Digital media – based sports activities}_i = \beta_0 + \beta_1(\text{Time preference}_i) + \beta_2(\text{Risk preference}_i) + \sum_{k=7}^k \beta_k X_{ik} + \epsilon_i \quad (3)$$

where X_{ik} is a set of covariates for individual i , as the same as in Equation (1). ϵ_i represents the residual term.

4. Results

4.1 Descriptive Statistics

We eliminated observations from fast responders, those with missing responses (i.e., respondents began answering a questionnaire and then stopped for whatever reason), or outliers (309 observations), resulting in 1016 valid observations remaining. We ensure that our survey participants underwent home confinement or were subject to centralized quarantine amidst the COVID-19 lockdown in Shanghai. The means, standard deviations, minimums, maximums, skewness, and kurtosis of the variables are presented in Table 1.

From a demographical perspective, 45.4% of survey respondents were male. 91.13% of them fell in the scope of 25 and 54 years old. Only 23.3% of respondents were unmarried, and 7.7% did not receive higher education. Almost

half of them (47.6%) had children under 12. 71.2% of participants reported that they did not face income risk. 904 survey participants (89%) intend to get vaccinated, and 708 individuals (69.69%) increased their bank savings as a precautionary measure to address potential risks like unemployment, health crises, or other emergencies following the lockdown.

Figure 1 displays the distribution of time preferences, which is left-skewed. Furthermore, Figure 2 portrays the distribution of general risk preference, which is left-skewed.

Table 1. Summary statistics (N=1016)

Sample variables	Mean	Standard deviation	Min	Max
<i>Dependent variables</i>				
Willingness to take all vaccine doses	89%	0.313	0	1
Bank savings increased	69.6%	0.460	0	1
Doing home-based sports via digital media	74.6%	0.435	0	1
<i>Variables of interest</i>				
Time preference	25.670	3.334	9	34
General risk preference	6.779	2.615	1	11
<i>Control variables</i>				
Male	0.454	0.498	0	1
Age	2.731	0.940	1	5
Marital status	0.767	0.423	0	1
Higher education	0.923	0.266	0	1
Annual household income	4.068	1.025	1	5
Children less than 12	0.476	0.499	0	1
Income risk	0.288	0.453	0	1
Number of observations	1016			

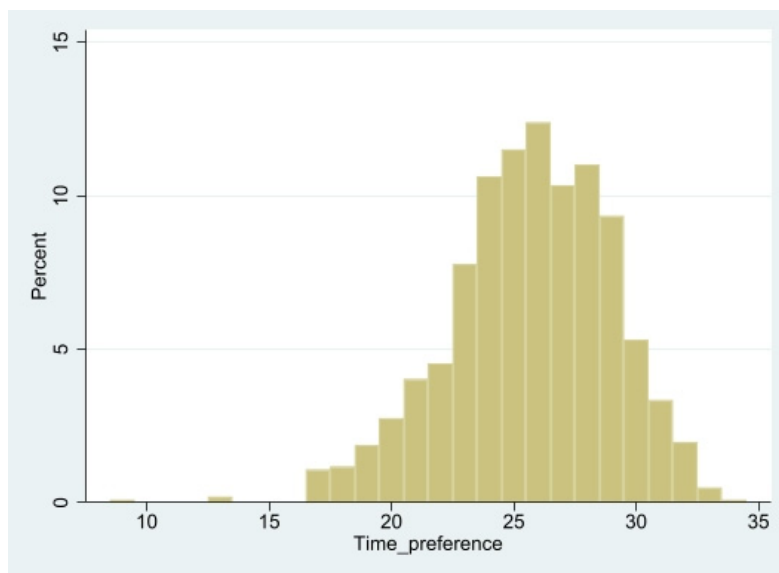


Figure 1. The distribution of time preference

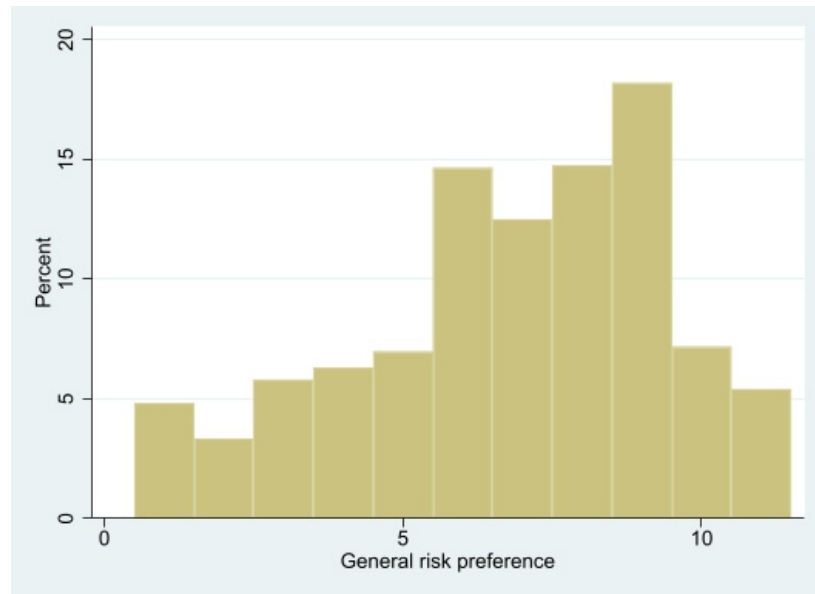


Figure 2. The distribution of general risk preference

4.2 Hypothesis testing

4.2.1 The inclination to receive COVID vaccines

We employed a binary logit regression model to explore the potential relationship between time preference, risk preferences, and willingness to receive vaccination. Table 2 portrays the estimated results. One primary variable of interest is the average marginal effect of “Time preference”. Its significance suggests that time preference is positively linked to the overall willingness to vaccinate, thus corroborating Hypothesis 1. For each one-unit increase in time preference (on a scale ranging from 9 to 34), there is a 0.9% increase in the probability of vaccination.

Furthermore, another primary variable of interest is the average marginal effect of “General risk preference.” The findings indicate a positive association between general risk preference and the willingness to complete all vaccine doses, thus supporting Hypothesis 2. Significantly, with every one-unit increase in general risk preference (on a scale ranging from 1 to 11), there is a 1% rise in the probability of vaccination.

The other average marginal effects in Table 2 indicate that the willingness to get vaccinated is higher for married and younger individuals, possibly reflecting that married ones tend to reduce the possibility of being infected and care about their family members’ health; young aged ones are more likely to accept new vaccines and less concerned about its side effect or effectiveness.

Table 2. The average marginal effect of time preference and general risk preference on the willingness to take COVID-19 vaccines

Dependent Variables: Willingness to Logistic Regression COVID-19 vaccines				
Variables	Average Marginal Effect	SE	z-Statistic	p-Value
Time preference	0.009***	0.003	3.280	0.001
General risk preference	0.010***	0.036	2.730	0.006
Male	0.027	0.022	1.250	0.211
Age	-0.031***	0.012	-2.620	0.009
Marital status	0.104***	0.028	3.680	0.000
Higher education	0.021	0.037	0.570	0.566
Annual household income	-0.021	0.011	-1.940	0.052
Children less than 12	-0.002	0.025	-0.090	0.931
Income risk	-0.022	0.021	-1.030	0.303
Log pseudolikelihood	-330.269			
Pseudo R2	0.063			
Number of observations		1016		

Note. ** and *** denote significance at the 5% and 1% levels, respectively. Robust standard errors were utilized. No multicollinearity was identified following the VIF test.

4.2.2 Saving behavior for unforeseen events

We attempt to determine whether time and general risk preferences are related to the probability of increasing bank savings. We conducted a binary logit regression model. Table 3 presents the estimated findings, and the primary variable of interest is the average marginal effect of “Time preference” and “General risk preference”. As we can see, time preference does not exhibit a statistically significant association with the augmentation of bank savings, thus failing to support Hypothesis 3. In addition, The findings suggest that general risk preference does not display a statistically significant connection with the inclination to augment bank savings, thereby failing to support Hypothesis 4.

The other average marginal effects in Table 3 indicate that precautionary saving is higher for individuals with high education attainment, income risk, and children less than 12 years old, which probably reflects that more educated ones save more for future uncertainty; income risk triggers precautionary saving for coping with no income problem when unemployed; saving more for bringing up young children.

4.2.3 Home-Based Sports Activities via Digital Media

A binary logit regression model examines whether time and general risk preferences predict physical exercise at home via digital media during the COVID-19 pandemic lockdown. Table 4 represents the estimated results. One primary variable of interest is the average marginal effect of “Time preference”, which implies that time preference is positively linked to engaging in home-based sports through digital media, thus providing support for Hypothesis 5. In particular, with each one-unit rise in time preference (on a scale ranging from 9 to 34), there is a 1.2% increase in the probability of participating in home-based sports through digital media.

Table 3. The average marginal effect of time preference and general risk preference on increasing bank savings

Dependent Variables: Increasing bank savings		Logistic Regression			
Variables	Average Marginal Effect	SE	z-Statistic	p-Value	
Time preference	0.007	0.004	1.59	0.112	
General risk preference	0.004	0.006	0.77	0.440	
Male	0.037	0.030	1.22	0.221	
Age	-0.013	0.017	-0.79	0.428	
Marital status	0.039	0.041	0.95	0.342	
Higher education	0.111**	0.055	2.01	0.044	
Annual household income	-0.004	0.015	-0.32	0.748	
Children less than 12	0.102***	0.034	2.97	0.003	
Income risk	0.164***	0.033	4.94	0.000	
Log pseudolikelihood	-594.933				
Pseudo R2	0.046				
Number of observations		1016			

Note. ** and *** denote significance at 5% and 1%, respectively. Robust standard errors were utilized. The VIF test revealed no evidence of multicollinearity.

Another primary variable of interest is the average marginal effect of “General risk preference”. Results show that general risk preference does not predict implementing physical exercise via media channels at home, which does not support Hypothesis 6.

The other average marginal effects in Table 4 indicate that the probability of doing digital sports is less for aged individuals and higher for individuals with high education attainment, possibly reflecting that senior individuals hesitate to physically exercise at home according to digital media due to degenerated physical function; university graduates may have a habit of doing sports even during the period of lockdown.

Table 4. The average marginal effect of time preference and general risk preference on doing home-based sports via digital media

Dependent Variables: Doing home-based sports via digital media		Logistic Regression			
Variables	Average Marginal Effect	SE	z-Statistic	p-Value	
Time preference	0.012***	0.004	3.14	0.002	
General risk preference	0.009	0.005	1.75	0.079	
Male	-0.017	0.027	-0.61	0.541	
Age	-0.073***	0.015	-4.73	0.000	
Marital status	0.024	0.039	0.60	0.545	
Higher education	0.141***	0.048	2.95	0.003	
Annual household income	0.015	0.013	1.17	0.241	
Children less than 12	0.059	0.032	1.87	0.061	
Income risk	0.026	0.029	0.89	0.376	
Log pseudolikelihood	-528.872				
Pseudo R2	0.081				
Number of observations		1016			

Note. ** and *** denote significance at 5% and 1%, respectively. Robust standard errors were utilized. The VIF test revealed no evidence of multicollinearity.

5. Discussion

In the present study, we inspected whether time preference and financial risk preference affect the inclination of individuals to receive vaccines and conduct indoor physical exercise through digital platforms, as well as to increase savings within the context of the zero-Covid policy. This study offers valuable insights by analyzing representative survey data gathered in Shanghai during and following the COVID-19 pandemic.

5.1 Time preference and the inclination to receive the COVID-19 vaccine

Our findings indicated that time preference positively correlates with taking COVID-19 vaccine doses. This discovery represents the initial empirical evidence connecting time preference to COVID-19 vaccine acceptance in China. In the literature, Okamoto et al. (2022) mentioned that factors associated with vaccine hesitancy include socio-demographic differences in gender, education level, and flu vaccination history (Wang, Yang, Jin, & Lin, 2021; Al-Amer et al., 2022; Truong, Bakshi, Wasim, Ahmad, & Majid, 2022), and psychological and behavioral factors, such as risk perception (Caserotti et al., 2021), fear (Willis et al., 2021), beliefs (Saied, Saied, Kabbash, & Abdo, 2021) and individual preferences (Cawley & Ruhm, 2011; Tsutsui et al., 2010). In addition, our finding is consistent with the results of previous studies. For example, Guillon and Kergall (2021) report a positive relationship between time preference and the willingness to COVID-19 vaccination based on their French sample collected by an online survey.

Similarly, a Japanese study conducted a conjoint experiment claiming that time preference predicts vaccine hesitancy (Okamoto et al., 2022). Nevertheless, there are still differences in their research. First, their findings are based on survey and experimental data from France and Japan, while we collect the survey data from China. Second, measure methods of time preference are not the same. They choose the French-validated 7-item version of Consideration of Future Consequences proposed by Demarque, Apostolidis, Chagnard, and Dany (2010) and a single self-reported question introduced by Frederick, Loewenstein, & O'donoghue (2002) while we construct an additive scale based on eight items reflecting future discounting from 8 perspectives of daily life, which is proposed by (Finke & Huston, 2013). Third, our survey participants experienced the Shanghai lockdown, while these two studies did not set such conditions during data collection.

Time preferences affect our decision-making related to health (Attema, 2012; Lawless, Drichoutis, & Nayga, 2013). One reason why future-oriented individuals tend to get vaccinated is that they believe the benefits of vaccination in the future outweigh the present concerns. The perceived benefits of vaccination are various, including reinforcing immunity and resisting virus (Reiter, Pennell, & Katz, 2020; Sherman et al., 2021) and relaxing public health restrictions due to an increased vaccine uptake rate (Okamoto et al., 2022). The present concerns comprise vaccine efficiency, ambiguity in protection level (Motta, 2021), fear of COVID-19, poor health literacy, and mistrust of authorities (Dhama et al., 2021).

5.2 General Risk Preference and the willingness for COVID vaccination

Similar to previous findings regarding the association between influenza vaccination (Tsutsui et al., 2012; Massin, Ventelou, Nebout, Verger, & Pulcini, 2015), HPV vaccination (Guo et al., 2020), and risk attitudes, our results show a positive relationship between risk preference and COVID-19 vaccination, which indicates that risk-taking individuals are more likely to get vaccinated.

The findings align with some previous research (Trueblood et al., 2022; Guillon & Kergall, 2021) regarding the connection between risk preference and the intention to take the vaccine. Even so, our sample population and risk preference measures differ from theirs. For example, they distribute their national survey among the US and French populations while we collect data from Shanghai citizens who have just experienced lockdown. Furthermore, Trueblood et al. (2022) use a choice question and ask participants how many lottery tickets last week they purchased to measure risk preference; Guillon and Kergall (2021) and Dohmen et al. (2011) use a single question to ask participants to rate their willingness to take the risk in health domain and in the general field, respectively.

For another, our findings are not consistent with other papers (Okamoto et al., 2022; Diza, Nuryakin, & Muchtar, 2022) in this concerned relationship. Notably, none report the effect of risk preference on vaccine-taking because the corresponding coefficients of risk preference in estimation are non-significant. Their results are based on Japanese online survey data and the fifth-wave Indonesian Family Life Survey data, respectively. Their measures of risk preference are different from ours. Okamoto et al. (2022) use a seven-point Likert scale proposed by Meertens and Lion (2008), while Diza et al. (2022) elicit risk aversion, which they define as one form of risk preference, through some questions answered by subjects. Therefore, national heterogeneity and different measures may contribute to this inconsistency among these studies.

Hence, explaining the underlying mechanism of why risk preference influences vaccination willingness becomes essential. Vaccination involves balancing risk-related choices: vulnerability and immunity (Binder & Nuscheler, 2017). Taking COVID-19 vaccines then seems like a potential risk that risk averters would like to avoid (Guillon & Kergall, 2021). Building on this insight and knowing risk preferences are stable during the COVID-19 pandemic (Drichoutis & Nayga, 2022), it is reasonable and essential to highlight vaccine efficacy and message its function to increase vaccine uptake of reducing the infection risk to the public in time.

5.3 Time Preference, General Risk Preference, and Precautionary Saving

Our results demonstrate that time and general risk preferences do not affect precautionary saving after experiencing the pandemic lockdown. Although, in the literature, financial risk preference is associated with a higher intention to save. While financial risk tolerance is associated with less sense of saving (DeVaney, Anong, & Whirl, 2007; Magendans, Gutteling, & Zebel, 2017), saving behavior is associated with a long-run planning horizon (Lee, Park, & Montalto, 2000; Chamon, Liu, & Prasad, 2013), our results are not in line with these mentioned findings.

Generally speaking, precautionary saving is contingent on individual characteristics related to consumption choices and savings decisions and the background in where these decisions are made (Lugilde et al., 2019). Therefore, the following reasons may contribute to this difference between previous empirical findings and our results. First, economic factors and sociological factors may be the primary factors influencing the choice of precautionary saving, such as the household's economic situation (Copur & Gutter, 2019), dependent children (Guariglia & Kim, 2003), financial socialization (Cho, Gutter, Kim, & Mauldin, 2012), education (Mishra et al., 2013; Kureishi and Wakabayashi, 2013), and income uncertainty (Baiardi et al., 2020). Second, under an uncertain environment (e.g., a lockdown caused by the pandemic), other psychological factors may contribute more to increased saving rate than individual preferences, such as self-efficacy (Lown, Kim, Gutter, & Hunt, 2015), perceived barriers to saving (Magendans et al., 2017), and being pessimistic to economy recovery throughout and after the pandemic (Zhang, Lu, Yin, & Zhao, 2021) because individuals higher in self-efficacy are more inclined to take precautions to alleviate adverse financial shocks and avoid default on their debt and bill payments after going through negative shocks (Kuhnen & Melzer, 2018). Plus, perceived barriers to saving lowers the intention to save (Magendans et al., 2017).

5.4 Time Preference, General Risk Preference, and Indoor Sports Activities by Using Digital Media

Our results show that time preference positively correlates with physical exercise at home with digital fitness apps or platforms. In contrast, general risk preference does not predict this type of physical exercise.

Our finding is partially the same as the empirical findings before 2020 because all results indicate a positive relationship between an individual's time preference and the individual's physical sports activities. For example, Kosteas (2015) reports that time preference predicts the amount of time spent in energetic physical exercise for women and men, based on the National Longitudinal Surveys of Youth 1979 (NLSY 79). A British study conducted a behavioral economic field experiment and stated that future-oriented participants did significantly more physical exercise than their present-biased counterparts (Hunter et al., 2018). More recently, also using NLSY 79, an American study conveys that time preference is positively associated with maintaining physical activity (Eberth, van der Pol, & Kemenev, 2020). In contrast, Norrgren (2022) does not find a significant relationship between time preference and physical exercise using the Swedish cohort dataset.

Nevertheless, there are still some differences between their studies and our study. First, our finding points out a positive association between time preference and fitness activities via social media platforms during the pandemic lockdown, which also constructs the primary contribution to the existing body of literature. Nevertheless, their results inform time preference matters for conventional physical exercise. Second, their research timing is before the COVID-19 outbreak. Third, all representative samples are from different countries; hence, national heterogeneity in culture, economic situations, or other perspectives may also account for the concerned relationship. Afterward, the ways to measure time preference are not the same. They all use a monetary trade-off option, but we employ a summary indicator constructed by some intertemporal behaviors proposed by Finke and Huston (2013). The latter is more effective in predicting intertemporal discounting than the former (Finke & Huston, 2013).

The possible mechanism is that future-oriented individuals are inclined to choose the healthier option to maintain their health in the long term. Subsequently, during the pandemic and lockdown, these people are more likely to keep fit and exercise at home via social media channels. Consequently, a strengthened immune system and good physical function are rewarded for mitigating infectious risk and securing general health.

5.5 Practical Implications

Based on our findings, several practical implications can be drawn. First, constructing interventions among risk-averse and present-oriented people to raise immunization uptake is essential. One intervention is to build information campaigns highlighting the infection risk of not taking the COVID-19 vaccines and how much these risks would be diminished due to vaccination. Notably, public health experts and policymakers can make an effort to train citizens' numerical capability to understand numerical information regarding side effects, and the evidence of effectiveness can prevent them from expecting too much of the risk of getting vaccinated (Caserotti et al., 2021; Garcia-Retamero, Sobkow, Petrova, Garrido, & Traczyk, 2019). The reason is that improving vaccine accessibility or awareness might not be as helpful as minimizing risk perception (Trueblood et al., 2022). Another intervention could be establishing information campaigns that underline the short-term benefits of vaccinating, such as less restriction on traveling across different administrative regions (Guillon & Kergall, 2021).

Second, to facilitate physical activity during the pandemic lockdown, interventions should aim to shift intertemporal discounting to favor long-term consequences, which could mitigate one's desire to reward presently (Hunter et al., 2018). From policy makers' perspective, particular solutions could be to train cognitive skills, such as attention, memory ability, and executive control, which can change time preference biases (O'Donoghue and Rabin, 1999; Radu, Yi, Bickel, Gross, & McClure, 2011), or to use contingency management interventions to reinforce desired behaviors (here, i.e., physical exercise at home via apps) through financial incentives, such as vouchers or other tangible rewards (Hall & Fong, 2007).

5.6 Theoretical Contributions

Scholars find that many crucial decisions are frequently made in situations of uncertainty (Guo, Chen, & Liu, 2022). The impact of COVID-19 is extensive, encompassing delays in various aspects, including the time it takes for vaccine distribution, the likelihood of fresh outbreaks, the period during which closure policies are in effect, the duration for the economy to recover post-pandemic, as well as changes in saving and spending patterns (Altig et al., 2020). We contribute to the literature by presenting evidence that risk preference and intertemporal choices predict the willingness to take the COVID-19 vaccines in China. In addition, our research extends the literature by demonstrating that these individual preferences do not influence precautionary savings. Furthermore, we add to the literature by documenting how time preference can predict doing sports at home via digital media during the pandemic lockdown.

5.7 Limitations of the Study and Directions for Future Research

We should acknowledge certain limitations of the current study. Firstly, our findings are based on a survey. The randomly picked sample from the registered panel may be less representative of Shanghai's general working population because these participants tend to have higher levels of education. Hence, people with lower levels of education may have lower coverage. Secondly, regional variations may exist since this research was carried out solely in Shanghai. Authorities' responses and policies to the pandemic and reasons for taking the vaccine, saving in advance, and exercising at home using digital apps may vary across countries and regions.

Risk and time preferences are stable amid the COVID-19 pandemic (Drichoutis & Nayga, 2022). By taking notice of these limitations, providing intertemporal and cross-national evidence on this topic would be an exciting line of future inquiry.

6. Conclusion

Economic theory states that time and risk preferences are vital in decision-making in many aspects of life (Tasoff & Zhang, 2022). They influence individuals' financial behaviors, for example, their saving rate (Mudzingiri, Muteba Mwamba, & Keyser, 2018), asset allocation (Alserda, Dellaert, Swinkels, & van der Lecq, 2019), insurance decisions (Baillon, O'Donnell, Quimbo, & van Wilgenburg, 2022), and their health behaviors, for instance, smoking (Harrison, Hofmeyr, Ross, & Swarthout, 2018), and exercise (Lopez-Guzman, Konova, & Glimcher, 2019). The COVID-19 pandemic brought external threats to public health and the global economy (Drichoutis & Nayga, 2022). People behave in advance in health and finance domains to cope with this dynamic change (Altig et al., 2020). This study was carried out using an online survey involving 1016 residents of Shanghai, which aims to investigate whether risk and time preferences influence vaccine taking, precautionary saving, and performing home-based sports via digital media.

Our results are a vital reference for public health authorities, psychological consultants, fitness clubs, and gyms. First, risk-taking and future-oriented individuals are inclined to get vaccinated, which calls for building information campaigns to underpin the infection risk of not getting vaccinated and how much this risk can be reduced after vaccination.

Second, future-oriented people are more likely to exercise at home using digital media because this action is believed to maintain physical and mental health and prevent and improve minor diseases' symptoms (Frías-Armenta et al., 2021). Interventions could be using financial incentives to support this indoor activity or altering time preference biases via cognitive skills training.

Third, neither risk nor time preference influences precautionary saving.

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The authors declare that there are no competing or potential conflicts of interest.

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Clinical Evaluation and Diagnosis of Prevalent Thyroid Disorders in Primary Care: A Comprehensive Case Series

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Abstract

Thyroid disorders are prevalent in primary care settings, encompassing a wide spectrum of disorders such as hypothyroidism, hyperthyroidism, and thyroid nodules. Early and accurate diagnosis is crucial for effective management and improved patient outcomes. This case series provides an overview of the key diagnostic approaches for common thyroid diseases in primary care.

The diagnosis of common thyroid diseases in primary care relies on a combination of clinical assessment, laboratory tests, imaging studies, and, if necessary, biopsy. Early and accurate diagnosis is essential for guiding appropriate treatment strategies and optimizing patient well-being. Primary care physicians play a vital role in identifying and managing thyroid disorders, ensuring that patients receive timely and effective care.

Keywords: Clinical evaluation, comprehensive assessment, thyroid disorders, primary care

1. Introduction

Thyroid disorders affect individuals of all ages, genders, and socioeconomic backgrounds worldwide. Developed countries usually diagnose thyroid disorders early due to better healthcare access, while developing countries face challenges in diagnosis and treatment. Hypothyroidism is more prevalent in developed countries, while hyperthyroidism is more common in developing countries. In the Middle East, iodine deficiency contributes to high hypothyroidism rates, while autoimmune thyroid diseases are becoming more prevalent due to lifestyle changes. Untreated or inadequately treated thyroid disorders can lead to various health complications and economic burdens. (Al Zabbi, 2020)

Thyroid disorders require a comprehensive patient history and examination by physicians in primary care to guide the ordering of diagnostic tests. Patients may present with a range of symptoms, including changes in weight, appetite, and energy levels, as well as eye and skin changes. Physical examination should include assessments of cardiac function, eye and skin texture. Also exam the thyroid gland for its size, consistency, tenderness, and presence of nodular lesion, along with laboratory tests for thyroid function (TFT) and autoantibodies. Differential diagnosis of thyroid disorders requires evaluation of tumor markers and imaging studies (Laurberg, 2011; Soh, 2019).

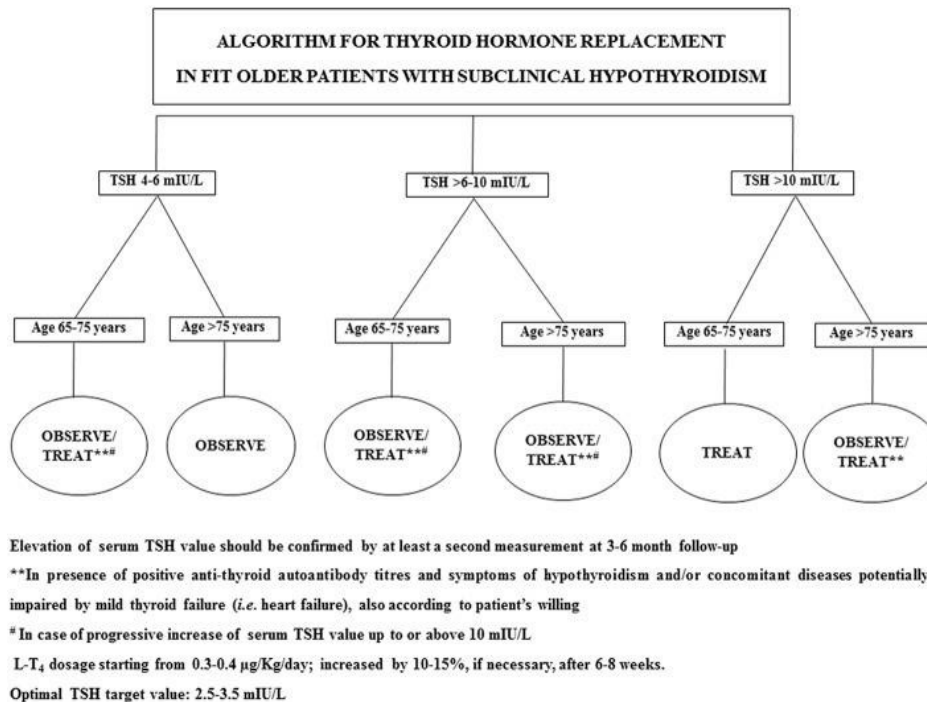
Case 1:

A 68-year-old female patient with a medical history of well-controlled diabetes mellitus (DM), hypertension (HTN), and hyperlipidemia presented to the health center to check her TFT showing thyroid stimulating hormone (TSH) levels of 7 mIU/L. while free triiodothyronine (FT3) and thyroxine (FT4) levels fall within the normal range. Notably, the patient did not exhibit any clinical manifestations of hypothyroidism.

1.1 Would you provide guidance on the appropriate diagnostic and therapeutic management for subclinical hypothyroidism in elderly patients?

In the evaluation of elderly patients with subclinical hypothyroidism, the recommended diagnostic workup involves several key steps. These include repeating the TSH test, assessing for the presence of thyroid antibodies, and conducting a comprehensive evaluation of the patient's medical history, frailty, comorbid conditions, and polypharmacy (Calsolaro, 2019).

When considering treatment, it is advisable to focus on patients between the ages of 65 and 75 who exhibit symptomatic progression with a TSH elevation to ≥ 10 m IU/L, have positive thyroid antibodies, or are dealing with concomitant heart failure in elderly age group. In such cases, the recommended approach is to initiate the use of the lowest effective dose of levothyroxine treatment, typically falling within the range of 0.3-0.4 micrograms per kilogram per day. The desired therapeutic goal is to achieve a target TSH level in the range of 2.5-3.5 m IU/L, and this can be accomplished using specified Algorithm 1.



Algorithm 1. Thyroid hormone replacement in fit older patients with subclinical hypothyroidism

Case 2

A 53-year-old female housewife presented with a history of progressive weight gain, memory loss, fatigue, constipation, and she had slow monotonous speech with a deepened voice. She was diagnosed with ventricular dysrhythmia and treated with amiodarone for the last three years. The patient was presented with stable vital signs, a body weight of 90 kilograms, and exhibited clinical signs consistent with moderate obesity, characterized by the presence of adipose tissue accumulation. Additionally, the individual displayed facial edema and a pallid cutaneous complexion. Further evaluation and assessment are warranted to ascertain potential underlying etiologies and to determine an appropriate course of management. The thyroid gland was not palpable, and ankle reflex time was delayed. Laboratory investigations revealed normal CBC results, a FT4 concentration of 2.8 ug/dl (N=4.5-12.5), a serum TSH level of 0.1 uU/ml (N=0.2-3.5), and a serum cholesterol level of 255 mg/dl (N<200).

2.1 What Is the Diagnosis, and What Approach Would You Take in Managing This Case?

The patient's clinical presentation, laboratory findings, and medication history collectively point toward a diagnosis of secondary or tertiary hypothyroidism, with a particular focus on amiodarone-induced hypothyroidism. Amiodarone, a commonly prescribed medication for the management of ventricular dysrhythmias, is known for its pronounced affinity for lipid-rich tissues, including the thyroid gland. This affinity can result in thyroid dysfunction.

In light of this diagnosis, it is advisable to refer the patient to a cardiology specialist for consideration of alternative treatment options. Specifically, the consideration of switching to medications like dronedarone, which exhibit lower affinity for fat-rich tissues and a reduced likelihood of adverse effects on TFT, is warranted. (Narayana, 2011)

Case 3

A 28-year-old female patient presents with a documented history of pre-existing hypothyroidism and is currently planning for pregnancy. Notably, she has no prior medical records indicating thyroid surgical interventions, thyroid malignancies, or exposure to radioactive iodine therapies. Prior to conception, the patient's TSH level was measured at 5 mIU/L, and she was on levothyroxine 25 Mg/ daily.

3.1 What Pre-Conception Advice Would You Recommend for Her Who is Planning for Pregnancy?

Preconception counseling plays a pivotal role in the prevention of adverse pregnancy outcomes associated with thyroid dysfunction. The elevated prevalence of thyroid disease within women of reproductive age, coupled with the heightened risk of unfavorable pregnancy outcomes linked to thyroid dysfunction, underscores the imperative need for well-established screening and therapeutic protocols during the preconception phase.

For women with a known diagnosis of hypothyroidism, it is imperative to provide counsel on adjusting their levothyroxine dosage by increasing daily 20-30% in cases of suspected or confirmed pregnancy, which may be indicated by a missed menstrual cycle or a positive pregnancy test. Notably, managing subclinical hypothyroidism proves to be advantageous, particularly in the presence of autoimmune conditions or in patients undergoing assisted reproductive techniques.

Following the adjustment of levothyroxine treatment to a daily dose of 50 micrograms, the patient's TSH levels were maintained at 2.5 mIU/L, aligning her with the suitability for adjusting levothyroxine dosage in pregnancy as dictated by prevailing medical Kaplan guideline (Table 1). (Sullivan, 2019)

3.2 What is the Appropriate Method for Adjusting Thyroxine Dosage in Pregnant Women with Hypothyroidism?

The recommended approach for adjusting levothyroxine dosage during pregnancy involves measuring the TSH level one month after conception and ensuring that it is within the acceptable range (≤ 2.5 mIU/L). Subsequent TSH measurements should be taken in each trimester and after delivery to further adjust the levothyroxine dosage as needed (Table 1). It is important to note that all laboratory tests should be conducted at least 6 hours after taking levothyroxine medication, and a minimum of 5 cc of blood is required for testing purposes (Sullivan, 2019).

Table 1. Kaplan guidelines for thyroxine adjustment during pregnancy

TSH level(mIU/L)	Alterations in Levothyroxine Dosage
TSH ≤ 2.5	Same dose
2.5 < TSH ≤ 5	↑ 25 μ g to the previous dose
5 < TSH ≤ 10	↑ 50 μ g to the previous dose
10 < TSH ≤ 20	↑ 75 μ g to the previous dose
TSH > 20	↑ 100 μ g to the previous dose

In most cases of well-controlled hypothyroidism during pregnancy, an increase in a levothyroxine dosage is necessary even in postpartum. The levothyroxine dosage should undergo a 50% augmentation during the initial trimester, followed by iterative 5% incremental adjustments during each subsequent trimester for optimal hypothyroid management during pregnancy. However, due to inter-individual variability, not all pregnant women may require such adjustments, and in some cases, a decrease in a levothyroxine dosage may even be necessary. Therefore, individualized drug adjustments should be made based on laboratory results and clinical improvement scale, whenever feasible (Sullivan, 2019).

Case 4:

A 48-year-old male patient presented at a local health center exhibiting a constellation of symptoms, including fatigue, irritability, neck discomfort, and a recent history of fever. Despite multiple prior visits, he received a diagnosis of an upper respiratory tract infection and was administered supportive care. His symptoms subsequently escalated to encompass tremors, palpitations, sweating, and tachycardia.

Both the patient's personal and familial medical histories were unremarkable, with the exception of his recent resolution of upper respiratory tract infection symptoms approximately 12 days prior. During the clinical examination, the patient displayed tenderness and mild swelling in the neck region, an elevated pulse rate (120 bpm), and peripheral tremors.

The TFT unveiled aberrant results, including slight elevated FT3 levels at 3.55 nmol/L (normal range: 1.20–3.10), heightened T4 levels at 230 nmol/L (normal range: 60–181 nmol/L), and a reduced TSH level at 0.011 mIU/L (normal range: 0.27–4.20 mIU/L). Furthermore, the patient exhibited elevated levels of anti-thyroperoxidase antibodies at 14.2 U/ml (normal range: <9 U/ml), increased anti-thyroglobulin antibody levels at 28 U/ml (normal range: <18 U/ml), While he had normal TSH receptor antibody levels at level 1.30 IU/L (normal range: <1.75 IU/L).

4.1 Would You Provide a Diagnosis Based on the Clinical Presentation and Laboratory Investigation

It is a case of subacute granulomatous thyroiditis (subacute painful or de-Quervain thyroiditis) with the feature of transient hyperthyroidism.

4.2 How Would You Approach the Management of This Patient Based on the Diagnosis and Other Clinical Factors?

The patient should be reassured about the self-limiting nature of post-viral subacute thyroiditis. It is characterized by a three-phase clinical course involving hyperthyroidism, hypothyroidism, and eventual restoration of normal TFTs. Treatment should consist of beta-blockers, short-course corticosteroids, and analgesia. Frequent monitoring through follow-up appointments, ideally every two weeks, is essential until both clinical symptoms and TFT return to baseline levels. Symptoms related to post-viral subacute thyroiditis may endure for a duration of 1-3 months, with full recovery expected. The normalization of TFT may take anywhere from 12 to 18 months, and there is a 5% probability of developing permanent hypothyroidism (Elawady, 2022).

Case 5:

A 30-year-old male expatriate with pertinent medical history presented with a constellation of symptoms including nervousness, memory impairment, reduced work performance, heat intolerance, agitation, tremors, and a significant weight loss occurring over a span of three months duration. Importantly, there was a positive family history of thyroid disorders.

Upon physical examination, the patient displayed exophthalmos, tremors, thyroid enlargement, and a notably elevated heart rate of 115 beats per minute. Laboratory findings indicated TSH level of 0.020 uU/mL, FT4 level elevated at 20.2 ug/dL (normal range: 5.0-12.0), anti-thyroglobulin antibodies exceeding 3000 IU/mL (with negative defined as <60 IU/mL, equivocal as 60-100 IU/mL, and positive as >100 IU/mL), anti-thyroid peroxidase antibodies measuring 2880 IU/mL (with a normal range of < 60 IU/mL), and anti-TSH receptor antibodies registering at 70% inhibition (normal range \leq 16.0 Unit).

5.1 Based on the Clinical and Laboratory Investigations, What is the Diagnosis for the Condition?

The clinical and laboratory diagnosis was Graves' disease (hyperthyroidism, thyrotoxicosis) (Table 2).

5.2 What is the Management Plan for This Patient Based on Their Diagnosis and Clinical Presentation?

Prior to the onset of the antithyroid drug's therapeutic effect, symptomatic treatment is often necessary. Beta-blockers serve as a valuable option for symptom control. Various beta-blockers demonstrate comparable effectiveness in alleviating the adrenergic manifestations of thyrotoxicosis, including palpitations, tachycardia, tremors, anxiety, and heat intolerance. In situations where beta-blockers are either poorly tolerated or contraindicated (e.g., in cases of asthma), a nondihydropyridine calcium channel blocker can be employed to regulate heart rate.

Thionamide antithyroid drugs, namely carbimazole and propylthiouracil, operate by inhibiting thyroid peroxidase, thereby diminishing the synthesis of thyroid hormones. Carbimazole is the primary choice among thionamides for most patients, as it facilitates a swifter normalization of thyroid hormone levels, exhibits reduced hepatotoxicity, and allows for once-daily dosing due to its extended half-life. Propylthiouracil, on the other hand, is the preferred antithyroid drug during the first trimester of pregnancy, for managing thyroid storm (owing to its additional inhibition of the conversion of T4 to T3), and in cases where minor adverse reactions to carbimazole occur, particularly when radioactive iodine or surgical interventions are not deemed suitable.

The initial dosage of carbimazole was established at 0.75 mg per kilogram per day, equivalent to a total of 45 mg per day, with the option for escalation to 1 mg per kilogram per day as necessary to achieve the normalization of T4 levels. Furthermore, it is advisable for the patient to incorporate a low-dose thyroxine supplementation at a rate of 75 μ g per square meter during the initial four months of treatment (Wood, 2022).

Table 2. LFT and radioiodine uptake in thyroid dysfunction

Physiologic state	Serum TSH	Serum Free T4	Serum T3	24-h radioiodine uptake
Hyperthyroidism, Untreated	Low	High	High	High
Hyperthyroidism, T3 toxicosis	Low	Normal	High	Normal or High
Primary Hypothyroidism, untreated	High	Low	Low or Normal	Low or Normal
Hypothyroidism Secondary to Pituitary disease	Low or Normal	Low	Low or Normal	Low or Normal
Euthyroid, on exogenous Thyroid hormone	Normal	Normal on T4, Low on T3	High on T3, Normal on T4	Low

Case 6:

A 28-year-old physically active female patient received a diagnosis of a benign thyroid nodule approximately four years ago. However, over time, she began experiencing pressure symptoms, particularly while swallowing solid foods, as the right-sided thyroid nodule rapidly expanded. The patient had no previous history of radiation exposure, and her personal and family medical history was unremarkable.

Upon physical examination, a warm and solid right thyroid nodule measuring three centimeters in diameter was identified. Her TFT fell within the normal range. Nevertheless, a thyroid ultrasound revealed a three-centimeter hypoechoic solid mass, raising a high suspicion of malignancy. Fine-needle aspiration (FNA) confirmed the diagnosis of papillary carcinoma.

In response, the patient underwent an extensive surgical procedure involving radical right neck surgery and total thyroidectomy. Pathological examination confirmed the presence of non-metastatic papillary carcinoma in the left lobe of the thyroid gland, along with metastatic lesions in the right lobe. Fortunately, no distant metastases were observed. Following the surgical intervention, the patient was placed on a lifelong regimen of levothyroxine at a daily dose of 100 mg.

6.1 What Is the Prevalence of Incidental Thyroid Nodules on Thyroid Ultrasound Expressed as a Percentage?

Incidental thyroid nodules, often discovered through thyroid ultrasound, are found at a notable prevalence, reaching as high as 68% in individuals without known thyroid issues. This occurrence is more frequently observed in aging females with obesity. Importantly, the vast majority, around 90% to 95% of such cases, are benign in nature (Kant in 2020).

6.2 What Are the Factors that Increase the Risk of a Thyroid Nodule Being Malignant?

Risk factors that elevate the likelihood of malignant thyroid nodules encompass exposure to ionizing radiation, the abrupt and significant enlargement of nodules, the onset of hoarseness, positive family history of thyroid cancer and the presence of familial adenomatous colon polyposis. A small fraction of benign thyroid nodules, approximately 2%, possess the potential for malignancy. Further molecular testing of these nodules can offer valuable insights into the underlying mechanisms responsible for the early progression to malignancy. (Kant, 2020).

Case 7:

A 30-year-old unmarried female with an unremarkable medical history sought TFT due to her mother's history of hypothyroidism. She reported experiencing hair loss and had been taking biotin supplements for four months, which had resulted in an improvement in her hair condition. Physical examination did not reveal any abnormalities, and her additional laboratory tests, including both liver, renal function test and complete blood test, were all within normal ranges.

Her TFT showed TSH level of 0.01 μ IU/mL, falling below the established reference range of 0.4-4.6 mIU/L. The FT4 level was elevated at 26 pmol/L, surpassing the reference range threshold of 10-19 pmol/L, while the FT3 level measured 8 pmol/L, also exceeding the reference range of 3.5-6.5 pmol/L. Further inquiry into the patient's history revealed no iodine exposure, recent fever, medication use, or symptoms indicative of thyrotoxicosis.

7.1 What Is the Medical Explanation for the Abnormal Thyroid Function Tests in This Patient?

Biotin (B7) is frequently used by patients for improving the health of their nails and hair, aiding in weight loss, and boosting energy. However, biotin is a water-soluble vitamin that interferes with TFTs, causing falsely elevated

or decreased levels of TSH, FT4, and presence of TSH receptor antibodies. This interference may lead to a misleading interpretation of the biochemical pattern of Graves' disease, characterized by low TSH, increased FT4, and positive antibodies to the TSH receptor, despite the absence of symptoms or signs of thyroid dysfunction (Zhang, 2020).

7.2 What Would be the Most Appropriate Course of Action to Take in This Patient's Case?

The recommended course of action is to advise the patient to discontinue biotin supplements for at least 14 days and to repeat the TFTs. It is crucial to carefully review all medications and supplements the patient is taking and consider their clinical presentation (Zhang, 2020).

Case 8:

A 50-year-old female patient with a history of primary autoimmune hypothyroidism who has struggled with adherence to her prescribed daily levothyroxine regimen (100 mcg), the physician initiate a focused and compassionate dialogue to address her problem to the prescribed therapeutic protocol.

8.1 What Is the Recommended Management Approach for This Case?

A weekly regimen of levothyroxine administered as a single dose is a secure and efficacious approach, presenting a viable option for patients who exhibit non-adherence. Consequently, her attending physician initiated a once-weekly, high-dose levothyroxine therapy at 700 mcg. At a subsequent follow-up appointment which was conducted two months later, the patient reported sustained absence of symptoms related to heat intolerance, irritability, nervousness, or undue perspiration. Laboratory findings revealed TSH concentration of 0.8 mIU/L and FT4 level of 2.47 ng/dL. These results signify stable thyroid function and suggest an adequate response to the ongoing therapeutic intervention.

Weekly levothyroxine treatment protocol yields a relatively diminished degree of TSH suppression, with the mean TSH level consistently falling within the confines of the normal reference range. These observations imply that this therapeutic approach may warrant consideration as a viable alternative for a specific subset of noncompliance patients (Chiu 2022). Furthermore, it is imperative to emphasize patient education, undertake a meticulous review of the medication regimen, streamline the treatment plan, foster shared decision-making with the patient, and schedule regular follow-up consultations for the purpose of ongoing monitoring and discourse pertaining to any encountered challenges or treatment-related side effects. Additionally, the promotion of adherence through the utilization of reminder tools and an exploration of the patient's social support system should be integral components of the comprehensive care plan.

Case 9:

A 35-year-old pregnant woman, currently at 10 weeks of gestational age, was asymptomatic and had a history of 5 pregnancies (gravida) with 4 live births (para) and no history of pregnancy loss (abortions). Her comprehensive laboratory investigation, which included a complete blood count, renal function, liver function tests, and a lipid profile, yielded normal results. However, her TFTs displayed low TSH level at 0.05 mIU/L, elevated FT4 levels at 20 µg/dL, and T3 levels at 6 ng/dL. Furthermore, her thyroid antibody levels were within normal limits.

Despite an unremarkable medical history and physical examination, the patient consistently maintained a state of euthyroid, exhibiting no signs or symptoms of thyroid dysfunction. This was confirmed by repeated thyroid function tests, which showed consistent results after one week, reinforcing her euthyroid status.

9.1 What Is Your Understanding of Atypical Thyroid Function Test Results?

In the case of this patient during her first trimester of pregnancy, her TFT indicated low serum TSH levels and elevated serum FT4 and FT3 levels, which exceeded the typical levels seen in non-pregnant adults. When assessing TFT during pregnancy, it is critical to apply trimester-specific reference ranges for serum TSH and FT4 levels.

It is important to note that trimester-specific reference ranges for serum TSH in pregnant Arab women may differ from the reference ranges recommended for non-pregnant adults, with the former typically showing higher values. Therefore, it is crucial to exercise caution when interpreting TFT results in pregnant women and to avoid common errors in the interpretation of TFT in individuals at different stages of pregnancy (Table 3) (Khalil, 2018)

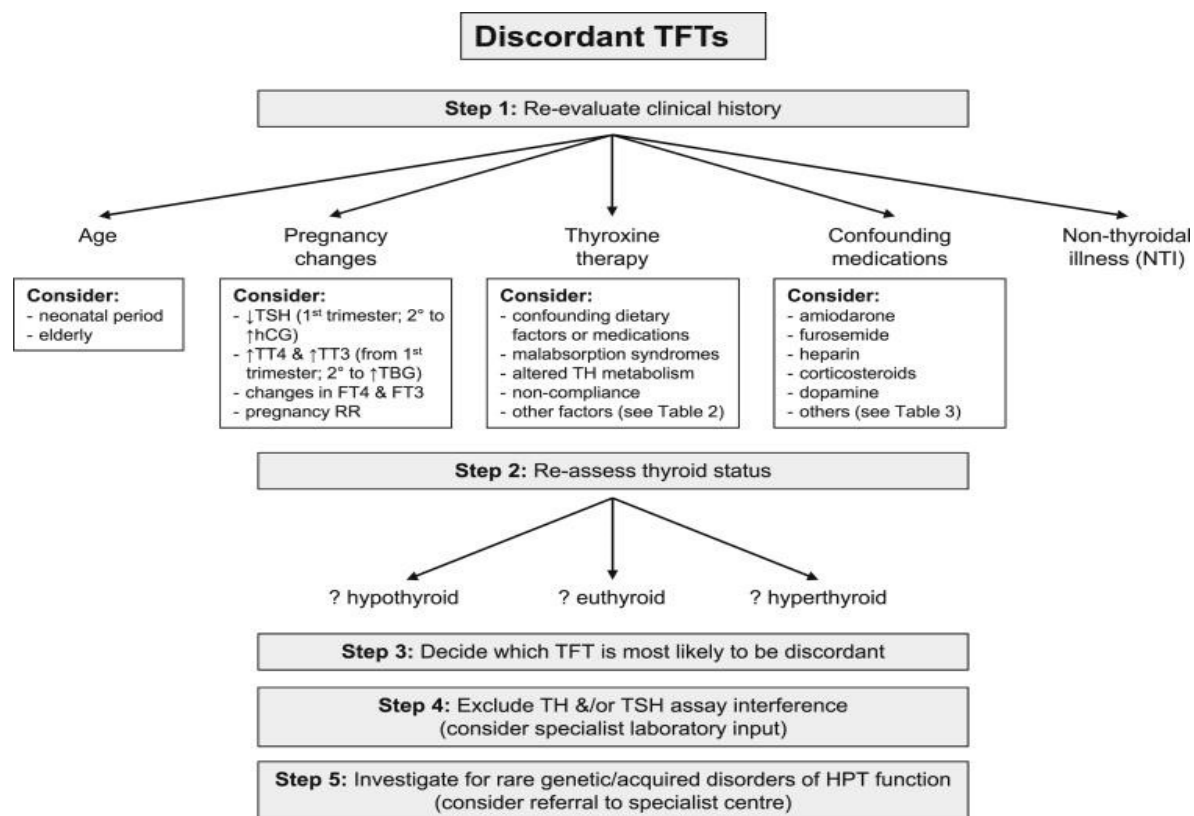
Table 3. Trimester-specific reference ranges for serum TSH and FT4

Trimester-Specific Reference Intervals for Thyroid Function Tests:	
1st Trimester:	
• FT4 (pmol/L) Reference Range:	11.73 – 20.39
• TSH (mIU/L) Reference Range:	0.094 – 3.33
2nd Trimester:	
• FT4 (pmol/L) Reference Range:	9.25 – 17.22
• TSH (mIU/L) Reference Range:	0.052 – 4.56
3rd Trimester:	
• FT4 (pmol/L) Reference Range:	8.71 – 15.26
• TSH (mIU/L) Reference Range:	0.44 – 4.75

9.2 What Is Meant by Discordance in the Interpretation of TFTs?

Numerous factors can introduce discrepancies or challenges in the interpretation of TFTs, as delineated in algorithm two, (Koulouri 2013). These factors encompass:

- Age-related variations, particularly in neonates and elderly individuals.
- The influence of pregnancy, particularly during different trimesters.
- The administration of thyroxine therapy or the existence of malabsorption disorders.
- The usage of medications known to potentially interfere with TFT results, such as Amiodarone or Lithium.
- The presence of non-thyroidal illness (NTI) in severely ill hospitalized patients, alongside psychiatric conditions, substance misuse, or the usage of specific psychiatric medications.



Algorithm 2. Discordant TFT interpretation

Case 10:

A 29-year-old female presented for a routine check-up without any noticeable symptoms. She had a positive family history of hypothyroidism in her mother and grandmother. The physical examination did not reveal any palpable thyroid enlargement, and her Body Mass Index (BMI) and blood pressure were within the normal range.

Laboratory investigations revealed positive thyroid peroxidase antibodies (TPOAb) with a value of 37.1 IU/mL (normal range, <28 IU/mL) and negative thyroglobulin antibodies (TgAb) with a value of 1 IU/mL (normal range, <100 IU/mL). Her lipid profile showed elevated cholesterol levels of 6.7 mmol/L (normal range, 3.6-5.2 mmol/L) and triglyceride levels of 1.9 mmol/L (normal range, 0.2-1.8 mmol/L). Notably, her TSH level was within the normal range, with a value of 1.53 mIU/L (normal range, 0.25-5.0 mIU/L).

10.1 What Is the Significance of Thyroid Antibodies?

The levels of thyroid antibodies, particularly thyroid peroxidase antibodies (TPOAb) and thyroglobulin antibodies (TgAb), can be indicative of various thyroid disorders such as Graves' disease, Hashimoto's disease, and thyroid cancer. Specifically, TPOAb levels are known to increase in these disorders, while thyrotropin receptor antibodies (TSHRAb) tend to increase only in Graves' disease. In the case of Hashimoto's disease, elevated levels of TgAb are often observed. These associations are further illustrated in Table 4 (Soh, 2019).

Table 4. Thyroid Antibodies

Autoantibody	Abbreviation	Causes
Thyroid peroxidase antibody	TPOAb	Hashimoto's disease, Grave's disease, and thyroid cancer
Thyroid-stimulating hormone receptor antibody	TSHR-Ab	Strongly linked to Graves' disease
Thyroglobulin antibody	TgAb	More suggestive of Hashimoto's disease

10.2 How Should the Patient's Laboratory Investigations be Interpreted?

The patient investigation profile was characterized by a slight elevation in thyroid peroxidase antibodies (TPOAb). However, her TFT, inclusive of TSH and FT4, revealed values that fell within the recognized normal range, thus rendering therapeutic intervention unnecessary. Furthermore, the patient was diagnosed with hyperlipidemia. It should be noted that the potential association of hyperlipidemia with autoimmune thyroid antibodies remains a subject of ongoing debate in contemporary research (Srivastava 2017).

10.3 Is There a Potential Correlation between Dietary Intake and TPOAb Levels?

Research has revealed a correlation between the consumption of animal fats and butter and the presence of positive plasma thyroid peroxidase antibodies (TPOAb) and/or thyroglobulin antibodies (TgAb). Conversely, a diet rich in vegetables, dried fruit, nuts, and muesli has been associated with negative findings of TgAb and/or TPOAb. Additionally, dietary patterns that exhibit anti-inflammatory properties have been linked to negative findings of plasma TgAb and/or TPOAb (Matana, 2017).

10.4 What is your Approach If the Patient Had High TSH between 5-10 (Subclinical), with Positive Antithyroid Antibodies of High TPOAb, TgAb?

The initiation of levothyroxine therapy is indicated in the following scenarios:

- When the TSH level exceeds 10 mIU/l.
- In the presence of symptomatic hypothyroidism.
- When cardiovascular risk factors are evident.
- In the presence of positive Thyroid Peroxidase (TPO) antibodies.

The primary objective of levothyroxine therapy is to achieve the normalization of both antithyroid antibodies and TSH levels. The initial levothyroxine dose is recommended at 1.6 mcg/kg, contingent upon the presence or absence of concomitant cardiovascular disease (Gosi, 2021).

In summary, this extensive case series is dedicated to the clinical assessment and diagnosis of common thyroid disorders within the realm of primary care. By presenting a variety of clinical scenarios, our objective is to augment comprehension and advocate for the implementation of efficacious management approaches. Additionally, we underscore the crucial role played by primary care physicians in delivering high-quality thyroid healthcare.

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