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Advancing Quality of Life through Thalassemia Awareness with THALEA

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Abstract

Thalassemia is a serious hereditary disease, but most carriers are unaware of their risk, increasing the chance of having children with thalassemia major. Premarital screening is important, but awareness among youths remain low. To address this, we developed and validated the Thalassemia Education and Awareness (THALEA) Kit, a theory-based intervention for high school students using the ADDIE framework. THALEA contains nine educational materials and shows strong validity. The S-CVI/Ave was 0.95, and the average S-FVI/Ave was 0.96, indicating excellent agreement and validity across all items. In conclusion, THALEA has the potential to improve thalassemia knowledge and screening intentions among adolescents.

Keywords: Thalassemia diagnosis; Premarital counselling; Health education; Thalassemia prevention and control

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1.0 Introduction

Thalassemia is among the most common inherited blood disorders across the globe, with a particularly high prevalence across Asian and Middle Eastern countries (Chun et al., 2023). The condition strikes a heavy burden on affected individuals, families and even public health systems, as thalassemia major patients require lifelong blood transfusions and chelation therapy. These ongoing treatments often negatively impact their mental health and financial well-being, thereby severely affecting their quality of life. (Ibraheem et al., 2022). Countries like Malaysia, which subsidises treatments for these patients, are also economically compromised, as the lifetime cost of managing a single thalassemia major patient is estimated at approximately three million Ringgit Malaysia, which is equivalent to 714,000 United States Dollars (Shafie et al., 2021). Without early screening, two asymptomatic thalassemia carriers may unknowingly marry, with each pregnancy carrying a 25% risk of producing a child with thalassemia major (Ibrahim et al., 2020). Of particular concern is the estimate that Malaysia has over 2 million thalassemia carriers, with hundreds of new cases identified annually, a trend that highlights the persistent public health burden. This requires the urgent need for effective preventive strategies. Premarital screening for thalassemia in Malaysia has long been recognised as a pivotal prevention strategy; however, unlike premarital HIV testing, thalassemia screening remains voluntary and is not mandated by law. To address this, the government launched the National Thalassemia Prevention and Control Programme back in 2016, which introduced early screening for students in government secondary schools.

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However, this initiative excluded those enrolled in private secondary schools, despite their students being equally at risk of inheriting the disorder. Moreover, recent studies further indicate that awareness of thalassemia remains alarmingly low among young people, even with ongoing health promotion efforts (Mohd Nor et al., 2022). Hence, in response to this, we developed and validated the Thalassemia Education and Awareness (THALEA) Kit – a theory-driven educational intervention aimed at improving knowledge, shaping attitudes, and strengthening intentions to pursue screening voluntarily among private secondary school students. This effort can potentially advance the quality-of-life maintenance among the younger generation. Specifically, our efforts include:

To develop the THALEA Kit for private secondary school students to be delivered by medical personnel.

To determine the validity of the THALEA Kit.

2.0 Literature Review

2.1 *Thalassemia on the global and local platform*

There are approximately 15 million people who are currently living with thalassemia, and it is further estimated that 56,000 infants are born each year with severe forms of the disease (Thalassemia International Federation, 2023). The global prevalence of thalassemia carriers is even greater, with an estimated range between 1.5% and 4.8% of the population worldwide, which is equivalent to roughly 270 million individuals (Kattamis et al., 2020). Despite long-standing prevention efforts, thalassemia continues to be a significant public health issue in Malaysia. The Malaysian Thalassemia Registry in 2023 recorded 8,749 patients across the nation, emphasising the ongoing need for treatment and support. While new affected births have declined over the past few years, 34 infants were still born with severe forms of thalassemia in the same year, indicating the hereditary nature of the condition. The mortality rates remain a concern, as they have not seemed to waver since the year 2014, with 148 cumulative deaths reported at the end of 2023. These figures emphasise the urgent need to address effective and widely accepted preventive measures, to safeguard the future quality of life of the population and to reduce the burden of this debilitating hereditary disease.

2.2 *Clinical Theory of Thalassemia*

Thalassemia, a complex and diverse group of inherited blood disorders, is characterised by the reduced or absent synthesis of haemoglobin chains, resulting in impaired red blood cell function (Kattamis et al., 2020). The severity of thalassemia can vary widely. People who carry the thalassemia trait, often called as thalassemia minors or thalassemia carriers, usually have only mild changes in their blood and do not show obvious signs or symptoms. (Musallam et al., 2024). In contrast, thalassemia major is characterised by severe forms of anaemic symptoms such as shortness of breath, fatigue, and growth impairment, requiring frequent blood transfusions for survival (Thalassemia International Federation, 2021). Certain literature classifies thalassemia into transfusion- dependant thalassemia (TDT) and non-transfusion-dependant thalassemia (NTDT), based on the blood transfusion requirement. Many individuals remain unaware that the initial step of thalassemia screening is a straightforward and rapid process. They can be completed quickly and interpreted within a short timeframe. More advanced testing is only necessary when initial screening results are inconclusive or when a definitive diagnosis is required

2.3 *Thalassemia and the Quality of Life (QoL)*

Beyond the outward signs of anaemia, thalassaemia has a significant impact on patients' health-related quality of life (HRQoL). According to studies that employ the use of validated tools such as the SF-36, EQ-5D, and PedsQL, TDT patients regularly report worse scores across physical, emotional, and social dimensions when compared to the general population (Shafie et al., 2021). The burden of chelation therapy, the problems of iron overload, and the requirement for lifelong blood transfusions all contribute to fatigue, limited physical functioning, and long-term organ damage, all of which lower QoL (Chun et al., 2023). Overall well-being is further jeopardised at the family level by the high financial costs of treatment, the time needed for hospital visits, and carer stress (Alwi & Syed-Hassan, 2022). When taken as a whole, research demonstrate that thalassaemia not only reduces life expectancy but also negatively impacts daily functioning and psychological well-being, highlighting the significance of early detection and prevention measures in maintaining quality of life.

2.4 *Screening for Thalassemia*

Screening typically begins with a simple blood test complete blood count (CBC) or a full blood count (FBC), which evaluates red blood cell size and concentration. The test is performed by collecting a small blood sample, using standard venipuncture techniques. This is followed by a confirmatory haemoglobin analysis and molecular testing when indicated, which is in line with recent international and Malaysian guidelines. Many individuals remain unaware that the initial step in thalassemia screening is a straightforward and rapid process. They can be completed quickly and interpreted within a short timeframe. More extensive testing is only needed when initial screening results are inconclusive or when a definitive diagnosis is required, for example in complicated or borderline cases. Another form of thalassemia screening is a prenatal testing, which is available through government health services (Ibrahim et al., 2020). However, parents may consider terminating their pregnancy if the prenatal testing diagnoses a child with thalassemia major. That decision is considered culturally and religiously sensitive, particularly in Muslim-majority countries like Malaysia, where abortion is generally not permitted by the law (Kuek, 2022). Consequently, relying solely on prenatal diagnosis at the antenatal stage, may not be the most appropriate preventive strategy in a country with a rich cultural and religious background. Instead, the implementation of early

carrier detection through school-based programmes and premarital screening initiatives offers a more proactive, culturally acceptable, and ethically sensitive approach to reducing the incidence of thalassemia major births in Malaysia (Wong et al., 2011)

2.5 Educational Gaps and Awareness among Adolescents

Studies have shown how adolescents lack the awareness of hereditary transmission of thalassemia and the importance of screening, most often due to misconceptions about the carrier status, stigma and limited health education exposure (Hasanshahi & Khanjani, 2021). School-based health programmes in Malaysia have shown the potential to improve adolescent knowledge, but translating this into long-term behavioural change remains challenging. For example, the ‘Eat Right, Be Positive about your Body and Live Actively’ (EPaL) programme, targeting Malaysian adolescents, improved health knowledge and attitudes post intervention, but changes in intention and sustained behaviour were limited (Sharif Ishak et al., 2020). Another example is the *Eduvariome* programme, which promoted knowledge about thalassemia among school students. However, the evaluation is limited to assessing knowledge alone, thereby limiting its overall impact (Rashid et al., 2020). It is imperative to integrate health educational interventions with appropriate theories to guarantee effective and comprehensive outcome on adolescents.

2.6 The Theory of Planned Behaviour (TPB)

The TPB by Ajzen and Fishbein (1977), was chosen as the framework for this intervention because it has the potential to predict and improve behavioural intentions, which is the key outcome for the THALEA Kit. According to the TPB, attitudes, subjective norms and perceived behavioural control, collectively shape behavioural intentions, making the model well suited for designing health promotional interventions, see Figure 1. Extensive evidence supports its use, such as a recent randomised controlled trial in Iran, which found that a TPB-based programme significantly improved preventive behaviours among mothers of thalassemia patients (Zareban et al., 2024). Similarly, school-based interventions targeting diet and physical activities also reported positive gains in adolescent behavioural intentions (Jha et al., 2023). As for the Malaysian-context, the TPB is particularly relevant, as it accounts for cultural and social determinants - such as family expectations and peer norms - that strongly influence adolescent decision-making.

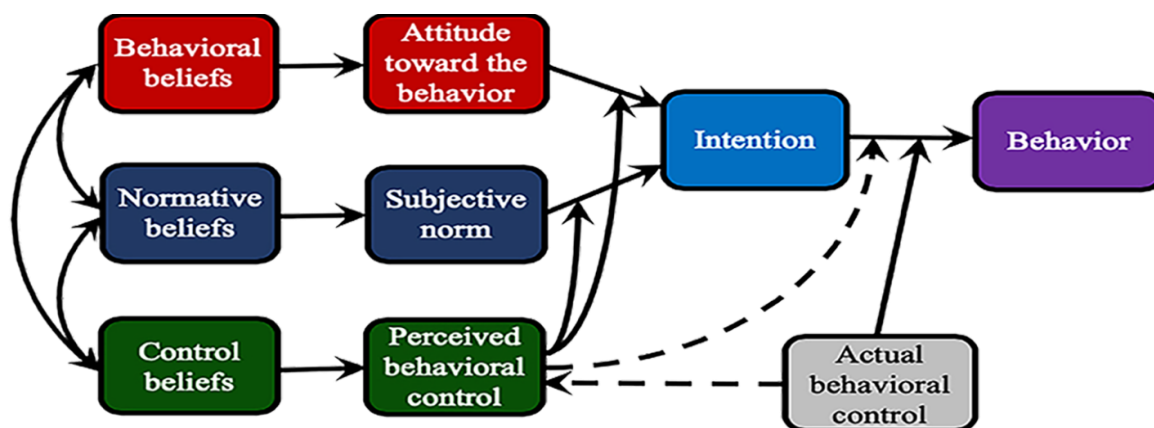


Fig. 1: The Theory of Planned Behaviour
(Ajzen and Fishbein., 1977)

2.7 Culturally Adapted Digital Edutainment Strategies

The integration of edutainment strategies, which combine education with entertaining elements, has become a powerful approach to engage adolescents in learning about health. Digital health interventions and multimedia tools which includes interactive platforms, have shown their ability to improve retention, motivation and health related outcomes, especially among the younger generation (Whitehead et al., 2024). In Malaysia's multicultural setting, cultural and linguistic adaptation can be critical for the effectiveness of health educational programmes. Studies of health literacy and knowledge indicate that younger and ethnically diverse populations require accessible content especially in a language that they can comprehend, to overcome the barriers to understanding (Azlan et al., 2021). Another study also proved how public perception on genetic testing is strongly influenced by cultural beliefs in Klang Valley, Malaysia (Chin & Tham, 2020). Therefore, apart from being digitally enhanced, health interventions should incorporate entertaining elements and be culturally adapted to the target population to maximise engagement, effectiveness and retention.

3.0 Methodology

The development and validation of the THALEA Kit followed the ADDIE instructional design model – Analysis, Design, Development, Implementation and Evaluation, see Figure 2.

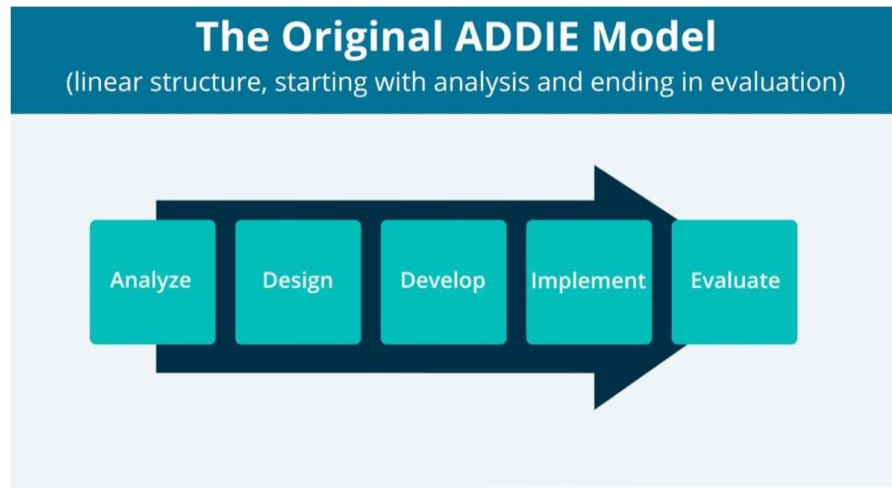


Fig. 2: The ADDIE Model
(Bouchrika, 2022)

3.1 Analysis phase

For the initial phase, two types of information were collected and utilised in a standardised manner. First being pre-existing information which are available online. These includes national guidelines, national registries, information from governmental health campaigns, research based in Malaysia and several international resources mainly from the World Health Organisation (WHO), the Thalassemia International Federation (TIF) and published international studies. The second information source were new information obtained from a panel of experts via the Modified Delphi Technique. The panel included nine experts from both the medical and education fraternity, each with more than 5 years of professional experience and bilingual proficiency in the Malay and English language. Both types of information were analysed, and findings were then used in the next stage of the ADDIE model.

3.2 Designing phase

In this phase, findings from the initial analysis were systematically mapped into the constructs of the TPB. The knowledge component was designed to address behavioural beliefs, such as understanding inheritance patterns and recognising the benefits of early screening. For the normative belief components, analytical findings suggested inclusion of peers and social acceptance. As for the perceived behavioural control, it is suggested that there is a need to provide students with a practical guide on how to access screening services in the country. Building on this, the attitude component was designed to foster positive perceptions toward premarital thalassemia screening. Additional reinforcements were also added to the components of subjective norms and control beliefs. Collectively, these elements were structured to strengthen students' intention to pursue premarital thalassemia screening which represents the outcome targeted by the second phase of this research.

3.2 Development phase

The development phase focused on producing a kit that could be easily delivered to secondary school students by healthcare personnel. As most clinical resources on thalassemia are available in English, the contents of the kit were drafted in English and then subsequently translated to the Malay language by two independent language and teaching experts. This is to ensure linguistic accuracy and reduction of bias. The majority of the materials were created by the researcher using digital design platforms such as Canva, while the comic book was illustrated by a professional illustrator. All content had been identified and refined during the initial analysis and design phase, enabling the development process to transform these resources into a cohesive educational kit.

3.3 Implementation phase

Following development, the implementation phase followed suit, in which the THALEA Kit was implemented in validation procedures. Two methods of validation were used which were the content and face validity. For content validation, nine experts independently evaluated each item using a four-point relevance scale, enabling calculation of the item-level content validity index (I-CVI) and the scale-level average content validity index (S-CVI/Ave). For face validation, 30 fourth form students from a private secondary school assessed the clarity, relevance, and cultural appropriateness of the materials using a four-point Likert scale, from which item-level (I-FVI) and scale-level (S-FVI/Ave) indices were computed.

3.4 Evaluation phase

According to established standards, an I-CVI of ≥ 0.78 and an S-CVI/Ave of ≥ 0.80 are considered acceptable (Nirdnoy et al., 2023). Calculations were made based on a formula by Polit & Beck (2006), as shown below:

Item-level content validity index formula:

$$I - CVI = \frac{Nc}{n} \quad (1)$$

Nc = Number of experts agreeing on each item (value 3&4)

n = Total number of experts

Scale-level content validity index formula:

$$S - CVI = \frac{\sum(I-CVI)}{p} \quad (2)$$

p = Total number of items

n = Total number of experts

For face validation, a minimum threshold of 0.83 is recommended (Yusoff, 2019). The formula used for face validity was also taken from Polit & Beck (2006) as shown below:

Item-level face validity index formula:

$$I - FVI = \frac{\text{Number of respondents who rated the item as 3 or 4}}{\text{Total number of respondents}} \quad (3)$$

Scale-level face validity index formula:

$$I - FVI = \frac{\text{Total I-FVI}}{\text{Total number of items}} \quad (4)$$

4.0 Results and Findings

4.1 Development outcomes

The THALEA Kit was finalised as a bilingual education package (English and Malay) to ensure understanding and cultural appropriateness for secondary school students in Malaysia. It was designed for delivery by healthcare personnel in school settings. The materials of the THALEA Kit are summarised in the table below.

Table 1. Materials of the THALEA Kit

Number	Materials	Format	Purpose/Function
1.	Slide presentation	Interactive Canva slide deck	Provides structured health education with prompts to stimulate discussion and engagement based on the behavioural beliefs' component of the TPB.
2.	Poster	Large-format print	Reinforces key messages on the normative beliefs and subjective norms components of the TPB.
3.	Comicbook	Illustrated booklet	Presents complex concepts in a youth-friendly, entertaining, and relatable format based on the behavioural beliefs' component of the TPB.
4.	Guidebook	Illustrated manual	Offers step-by-step information on inheritance, screening procedures, and service access based on the control beliefs section of the TPB
5.	Web-based quiz	Kahoot quiz	Assesses knowledge acquisition and reinforces learning through self-testing, mainly covers most of the components of the TPB
6.	Short videos (3)	Digital media clips	Complements other materials by delivering concise, visually engaging health messages

4.2 Content Validity Index (CVI)

The I-CVI value ranged from 0.89 to 1.00, reflecting strong consensus among the expert panel. Ten of the 15 items (66.7%) achieved perfect agreement (I-CVI = 1.00), while the remaining five items scored 0.89, which still surpassed the minimum recommended threshold of 0.78 for panels of six or more experts. At the scale level, the S-CVI/Ave was 0.95, indicating excellent overall content validity.

4.3 Face Validity Index (FVI)

Face validity testing, conducted among 30 secondary school students, used a four-point Likert scale as well, where participants rated the clarity, relevance and cultural appropriateness of the materials. The I-FVI scores ranged between 0.90 and 2.00, suggesting that nearly all items were perceived as clear and understandable by students. At the scale level, the S-FVI/Ave was calculated at 0.96, with 96% of raters agreeing that the THALEA Kit was clear, relevant, and appropriate.

5.0 Discussion

The application of the ADDIE instructional design model is vital to ensure that the development process was done systematically and with rigour. Each stage—from analysis to development and implementation—was carried out ensuring the involvement of both experts and students. Importantly, the involvement of experts from diverse fields, including healthcare professionals and teachers from different school backgrounds, added significant value to the development. Their combined perspectives guaranteed that the content was not only medically accurate but also appropriate for adolescents enrolled in different types of high schools. This multidisciplinary approach strengthened the overall quality and relevance of the THALEA Kit, which aligns with research recommendations that health education tools must integrate subject matter expertise with instructional design principles to maximise effectiveness (Li & Cheong, 2023).

The intervention was based on the TPB, which states that attitudes, subjective norms, and perceived behavioural control together shape behavioural intentions (Ajzen and Fishbein., 1977). By providing information on inheritance and the benefits of screening, reinforcing beliefs through family and peer support, and improving perceived control by offering practical guidance on accessing screening, the THALEA Kit was carefully designed to affect the psychological factors influencing screening intentions. This combined use of the ADDIE model and TPB, ensured the intervention was both methodically developed and theoretically sound, so that it has the potential to produce meaningful behavioural outcomes. Evidence from a randomised controlled trial in Iran shows that TPB-based programs can improve preventive behaviours among mothers of thalassemia patients (Zareban et al., 2024). Additionally, school-based programs guided by TPB have successfully shaped adolescent health intentions in areas like diet and physical activity (Jha et al., 2023). While direct evidence linking family and peer norms to thalassemia screening behaviour among Malaysian youth is limited, some studies indicate that peer pressure and parental bonding play important roles in predicting adolescents' risk-taking attitudes (Hanapi et al., 2023). These findings suggest that similar social influences might impact attitudes and intentions regarding health screening behaviours.

The validation findings of this study show that the THALEA Kit is a relevant, clear, and culturally appropriate educational tool for promoting thalassemia screening among private secondary school students in Malaysia. The content validity indices (CVI) were consistently high, exceeding recommended thresholds. This reflects a strong agreement among experts on the relevance and suitability of the materials (Nirdnoy et al., 2023). Similarly, the high face validity indices (FVI) from student evaluations confirm that they found the kit clear, understandable, and relatable to their sociocultural context. These results indicate that the THALEA Kit meets essential criteria for being scientifically sound, user-friendly, and suitable for the intended target group. This establishes a solid foundation for future implementation and outcome evaluation.

When compared to existing literature, the THALEA Kit shows several unique contributions. Previous efforts, like the *Eduvariome* programme, successfully boosted genetic literacy among students but only measured knowledge outcomes, with no mention on the theoretical development for the intervention (Rashid et al., 2020). Other pre-existing national health promotional efforts were also not targeted to specific groups as the focus was on the public. Additionally, many genetic education programs lack cultural or language adaptation, which limits their acceptance in diverse groups (Chin & Tham, 2020).

The THALEA Kit provides a validated and theory-based resource that healthcare personnel can easily use in school health education programs. Its availability in two spoken languages in Malaysia ensures that students from different verbal backgrounds can access it. The kit incorporates a comic, videos, and an interactive quiz, which may improve engagement and retention. This aligns with recent evidence that affirms the positive effects of digital and educational entertainment strategies for promoting adolescent health (Whitehead et al., 2024). Importantly, by focusing on private secondary school students, who are not included in the current National Thalassemia Prevention and Control Programme, the kit tackles an important policy issue. This demonstrates its potential to complement existing national efforts and broaden preventive strategies to group that have not been adequately reached.

Beyond the private school setting, this kit also shows potential for wider use. It's clear and culturally relevant design suggests that it can be applied in different educational contexts, including government schools and community youth programs. Additionally, the kit's digital flexibility allows it to be integrated into online health education platforms and national awareness campaigns, increasing its reach. In the long term, providing young people with accurate information and promoting positive attitudes and intentions toward screening may help reduce the impact of thalassemia in Malaysia. This effort aligns with public health goals to improve population health and quality of life (Alwi & Syed-Hassan, 2022; Ibrahim et al., 2020).

6.0 Conclusion and Recommendations

This study developed and validated the THALEA Kit and showed strong content validity, supported by agreement from experts in different fields. It also had high face validity among students, confirming that it is clear, relevant, and culturally suitable. These findings provide a solid basis for using it in promoting adolescent health. However, face validation was limited to students, leaving out parents and teachers, whose views could enhance the evaluation of clarity and acceptability. Usability testing with healthcare personnel who will deliver the kit was also not done. This step is crucial to ensure effective implementation. Future work should involve usability testing with healthcare personnel, engaging more stakeholders, and evaluating the kit's effectiveness in improving knowledge, attitudes, and screening intentions in the planned second phase. Expanding into public schools, using digital delivery platforms, and integrating into national prevention efforts are also ways to scale the project. Ultimately, THALEA has potential as a culturally adapted tool that can help reduce the burden of thalassemia and advance quality of life for the young people in Malaysia.

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Paper Contribution to Related Field of Study

This paper contributes to the field of public health especially in the educational and promotional field.

References

- Chun, G. Y., Mohd Tahir, N. A., Islahudin, F., Selvaratnam, V., & Li, S. C. (2023). Drug-related problems among transfusion-dependent thalassemia patients: A real-world evidence study. *Frontiers in Pharmacology*, 14, 1128887.
- Ibraheem, S. M., Sathar, J., Seman, Z., & Khalid, B. (2022). Malaysian socio-demographic characteristics, mean haemoglobin levels and BMI distribution of the monthly transfused group (MTG) and non-monthly transfused group (NMTG) thalassemia patients. *International journal of health sciences*. <https://doi.org/10.53730/ijhs.v6ns8.11528>
- Shafie, A. A., Wong, J. H. Y., Ibrahim, H. M., Mohammed, N. S., & Chhabra, I. K. (2021). Economic burden in the management of transfusion-dependent thalassaemia patients in Malaysia from a societal perspective. *Orphanet Journal of Rare Diseases*, 16, 1-12.
- Ibrahim, H. M., Muda, Z., Othman, I. S., Unni, M. N. M., Teh, K. H., Thevarajah, A., Gunasagaran, K., Ong, G. B., Yeoh, S. L., & Rivai, A. M. (2020). Observational study on the current status of thalassaemia in Malaysia: a report from the Malaysian Thalassaemia Registry. *BMJ open*, 10(6), e037974.
- Mohd Nor, M. A., Idris, N. S., Mohd Zulkifli, M., Abu Bakar, R., & Ahmad, I. (2022). Thalassemia screening: Low level of knowledge among unmarried youths in Kota Bharu, Kelantan, Malaysia. *Malaysian Family Physician*, 17(1), 57-65. <https://doi.org/10.51866/oa.31>
- Kattamis, A., Forni, G. L., Aydinok, Y., & Viprakasit, V. (2020). Changing patterns in the epidemiology of β -thalassemia. *European Journal of Haematology*, 105(6), 692-703. <https://doi.org/10.1111/ejh.13512>
- Musallam, K. M., Cappellini, M. D., Coates, T. D., Kuo, K. H., Al-Samkari, H., Sheth, S., Viprakasit, V., & Taher, A. T. (2024). Alpha-thalassemia: A practical overview. *Blood Reviews*, 64, 101165.
- Thalassemia International Federation (TIF). (2021).
- Alwi, Z. B., & Syed-Hassan, S.-N. R.-K. (2022). Thalassemia in Malaysia. *Hemoglobin*, 46(1), 45-52.
- Kuek, C. Y. (2022). The legal implications of prenatal diagnosis in Malaysia. *F1000Research*, 10, 1103.
- Wong, L. P., George, E., & Tan, J.-A. M. A. (2011). Public perceptions and attitudes toward thalassaemia: Influencing factors in a multi-racial population. *BMC Public Health*, 11(1), 193. <https://doi.org/10.1186/1471-2458-11-193>
- Hasanshahi, F., & Khanjani, N. (2021). Investigating the reasons for marriage among couples with thalassemia minor, in Iran. *Journal of Community Genetics*, 12(4), 507-513.
- Sharif Ishak, S. I. Z., Chin, Y. S., Mohd. Taib, M. N., Chan, Y. M., & Mohd. Shariff, Z. (2020). Effectiveness of a school-based intervention on knowledge, attitude and practice on healthy lifestyle and body composition in Malaysian adolescents. *BMC pediatrics*, 20(1), 122.
- Rashid, D., Hassan, N. N. N., Abdullah, W. Z., Azman, N. F., binti Hanafi, S., Haiyuni, M. Y., Bahar, R., Yusof, S. M., Hassan, M. N., & Nasir, A. (2020). Eduvariome HVP Malaysia: Promoting Knowledge and Awareness on Thalassaemia among Secondary School Students in North-East of Peninsular Malaysia. *Malaysian Journal of Human Genetics*, 1(2), 34-43.
- Fishbein, M., & Ajzen, I. (1977). Belief, attitude, intention, and behavior: An introduction to theory and research.
- Zareban, I., Oudi-Akbari, Z., Jadgal, M. S., Ansari, H., & Hosseinzehi Zamani, J. (2024). Effectiveness of the application of an educational program based on the Theory of Planned Behavior (TPB) in adopting preventive behaviors among mothers who have thalassemia children in Iran: a randomized controlled trial. *Egyptian Journal of Medical Human Genetics*, 25(1), 45.
- Jha, S. S., Dobe, M., Taklikar, C., & Lahiri, A. (2023). School-based intervention on behavioral intention of adolescents regarding healthy diet in India. *Frontiers in public health*, 11, 1094960.
- Whitehead, L., Robinson, S., Arabiat, D., Jenkins, M., & Morelius, E. (2024). The report of access and engagement with digital health interventions among children and young people: systematic review. *JMIR pediatrics and parenting*, 7, e44199.
- Azlan, A. A., Hamzah, M. R., Tham, J. S., Ayub, S. H., Ahmad, A. L., & Mohamad, E. (2021). Associations between health literacy and sociodemographic factors: A cross-sectional study in Malaysia utilising the HLS-M-Q18. *International Journal of Environmental Research and Public Health*, 18(9), 4860.
- Chin, J.-J., & Tham, H.-W. (2020). Knowledge, awareness, and perception of genetic testing for hereditary disorders among Malaysians in Klang Valley. *Frontiers in genetics*, 11, 512582.
- Bouchrika, I. (2022). The ADDIE Model Explained: Evolution, Steps, and Applications. In: *Research. com*. <https://research.com/education/the-addie-model>.
- Nirdnoy, N., Sranacharoenpong, K., Surawit, A., Pinsawas, B., Mongkolsucharitkul, P., Pongkunakorn, T., Manosan, T., Ophakas, S., Suta, S., & Pumeiam, S. (2023). Validation of a Thai semiquantitative food frequency questionnaire (semi-FFQ) for people at risk of metabolic syndrome. *Journal of Health, Population and Nutrition*, 42(1), 13.
- Polit, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. *Research in nursing & health*, 29(5), 489-497.

Li, H., & Cheong, J. P. G. (2023). Using the ADDIE model to design and develop physical education lessons incorporated with a functional training component. *Frontiers in public health*, 11, 1201228.

Hanapi, N. N. B., Yaacob, S. N., Daud, M. N., & Mansor, M. The Role of Peer Pressure, Parental Bonding, and Sensation Seeking in Predicting Risk-taking Attitude among Adolescents in Selangor, Malaysia.