MODELLING OF KNOWLEDGE AND CONSPIRACY BELIEFS ON CHILDHOOD VACCINE HESITANCY AMONG PARENTS IN KELANTAN USING MALAY VALIDATED QUESTIONNAIRES

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by

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LIST OF SYMBOLS

%	Percent
=	Equal to
≥	More than and equal to
≤	Less than and equal to
>	More than
<	Less than
α	Alpha
β	Beta
ρ_0	Minimum acceptability reliability
ρ_1	Expected reliability
p	p-value
r	Pearson correlation Coefficient
R^2	Coefficient of determination
χ^2	Chi square
n	Number of observations
m	Number of observed variables

LIST OF ABBREVIATIONS

AVE	Average variance extracted
BCG	Bacille-Calmette Guerin
B40	Bottom 40 percent household income group
CDC	Communicable Disease Control
CFA	Confirmatory Factor Analysis
CFI	Comparative fit index
CI	Confidence Interval
CR	Composite reliability
CVI	Content Validity Index
EFA	Exploratory Factor Analysis
EPI	Expanded Program on Immunization
FVI	Face Validity Index
HiB	Hemophilus influenza type B
HPV	Human Papilloma Virus
ICC	Intraclass correlation coefficient
I-CVI	Item- level content validity index
I-FVI	Item- level face validity index
IPH	Institute of Public Health
IQR	Interquartile range
KR-20	Kuder-Richardson Formula 20
KK	*Klinik Kesihatan*
MI	Modification indices
ML	Maximum likelihood
MLR	Robust maximum likelihood estimator
MMR	Measles, Mumps and Rubella
MOH	Ministry of Health
MVHS	Modified Vaccine Hesitancy Scale
M40	Middle 40 percent household income group
NHMS	National Health Morbidity Survey
NIP	National Immunization Program
OKS	One-dimensional Knowledge Scale

PACV	Parent Attitude about Childhood Vaccines
RMSEA	Root mean square error of approximation
SAGE	Strategic Advisory Group Experts
S-CVI	Scale-level content validity index
SD	Standard deviation
SE	Standard error
SEM	Structural equation modelling
S-FVI	Scale-level face validity index
SPSS	Statistical package for social sciences
SRMR	Standardised root mean square residual
TLI	Tucker-Lewis index
T20	Top 20 percent household income group
UNICEF	United Nations Children's Fund
VHS	Vaccine Hesitancy Scale
VPD	Vaccine-preventable Disease
VCBS	Vaccine Conspiracy Belief Scale
WHO	World Health Organization
WLSMV	Mean and variance adjusted weighted least square
WRMR	Weighted root mean square residual

LIST OF APPENDICES

PEMODELAN PENGETAHUAN DAN KEPERCAYAAN KONSPIRASI TERHADAP KERAGUAN VAKSIN KANAK-KANAK DALAM KALANGAN IBU BAPA DI KELANTAN MENGGUNAKAN SOAL SELIDIK BAHASA MELAYU YANG TELAH DISAHKAN

ABSTRAK

Latar Belakang: Keraguan vaksin kanak-kanak tetap menjadi kebimbangan kesihatan awam secara global. Pengetahuan telah diketahui mempengaruhi keputusan vaksinasi ibu bapa. Tambahan pula, teori konspirasi ketika pandemik COVID-19 telah menyebabkan keraguan semakin teruk. Walaubagaimanapun, kajian tempatan yang mengkaji tentang hubungan ini terhadap keraguan vaksin menggunakan instrumen Bahasa Melayu masih berkurang.

Objektif: Kajian ini bertujuan untuk menterjemahkan, adaptasi budaya dan mengesahkan skala Pengetahuan Satu Dimensi (OKS), skala Kepercayaan Konspirasi Vaksin (VCBS) dan skala Keraguan Vaksin edisi ubah suai (MVHS) ke dalam Bahasa Melayu. Seterusnya, kajian ini bertujuan membina model hubungan antara demografi, pengetahuan dan kepercayaan konspirasi terhadap keraguan vaksin kanak-kanak dikalangan ibu bapa di Kelantan menggunakan model persamaan struktur.

Metodologi: Kajian hirisan lintang ini terdiri daripada dua fasa. Fasa I, melibatkan penterjemahan dan adaptasi budaya bagi tiga skala dalam versi Bahasa Melayu, bermula April 2023 hingga Jun 2023. Skala telah diterjemahkan mengikut garis panduan yang ditetapkan. Kesahan kandungan dan kesahan muka telah dinilai oleh enam orang panel pakar dan 10 orang ibu bapa. Data dianalisa menggunakan Microsoft Excel 365. Fasa II diteruskan antara Julai 2023 hingga Mac 2024, melibatkan 270

orang ibu bapa yang mempunyai anak berumur ≤ 7 tahun. Analisa pengesahan faktor dijalankan untuk memastikan skala yang digunakan adalah sah dan boleh dipercayai untuk mengukur pembolehubah kajian, seterusnya model persamaan struktur dilakukan untuk menentukan hubungan antara pembolehubah. Kebolehpercayaan ujian semula ditentukan untuk memastikan kestabilan skala yang diterjemah. Data dianalisa menggunakan IBM SPSS versi 26 dan Mplus versi 8.

Keputusan: Fasa I, semua skala versi Bahasa Melayu telah mencapai skor yang telah disyorkan iaitu ≥ 0.83 untuk indeks item dan indeks skala bagi kesahan kandungan dan kesahan muka. Fasa II, skala M-OKS yang mempunyai 10 item menunjukkan kepadanan model yang baik (CFI= 0.976, TLI= 0.969, RMSEA (90%CI) = 0.053 (0.030, 0.074), WRMR = 0.877). Skala M-VCBS, terdiri daripada lapan item dan kolerasi antara item mencapai kepadanan model yang baik (CFI= 0.977, TLI= 0.967, RMSEA (90% CI) = 0.053 (0.020, 0.082), SRMR = 0.028). Skala MVHS-M, terdiri daripada sembilan item, merangkumi dua faktor iaitu "Kurang keyakinan" dan "Persepsi risiko" mencapai kepadanan model dengan penambahan korelasi antara item (CFI= 0.970, TLI= 0.957, RMSEA (90% CI) = 0.057 (0.031, 0.082), SRMR= 0.031). Julat kebolehpercayaan komposit bagi semua skala ialah 0.741 hingga 0.935 dan nilai AVE ≥ 0.5 menunjukkan semua skala mempunyai kesahan konvergen yang baik. Julat kebolehpercayaan ujian semula yang diukur oleh *Intraclass Correlation Coefficient* (ICC) ialah 0.730 hingga 0.854 menunjukkan kestabilan yang baik bagi semua skala. Model struktur terakhir mempunyai sepuluh hipotesis menunjukkan kepadanan yang baik (CFI= 0.961, TLI= 0.954, RMSEA (90% CI) = 0.040 (0.032, 0.053), SRMR= 0.043). Beberapa hubungan tidak langsung juga dikenalpasti berkait dengan keraguan vaksin

Kesimpulan: Kajin ini telah menghasilkan instrumen yang sah dan boleh dipercayai untuk mengukur pengetahuan dan kepercayaan konspirasi terhadap keraguan vaksin dikalangan ibu bapa di Kelantan. Kajian ini juga telah menunjukkan kesan pengetahuan dan kepercayaan konspirasi terhadap keputusan vaksinasi di kalangan ibu bapa, seterusnya menawarkan pandangan berharga kepada pihak berkuasa kesihatan awam dan pembuat dasar untuk merancang strategi bersasar bagi meningkatkan pengambilan vaksin.

Kata kunci: Keraguan vaksin, pengetahuan, kepercayaan konspirasi vaksin, analisa pengesahan faktor, model persamaan struktur

MODELLING OF KNOWLEDGE AND CONSPIRACY BELIEFS ON CHILDHOOD VACCINE HESITANCY AMONG PARENTS IN KELANTAN USING MALAY VALIDATED QUESTIONNAIRES

ABSTRACT

Background: Globally, childhood vaccine hesitancy remains a significant public health concern. Knowledge is well-known influence on the parental's vaccination decision. Additionally, in light of COVID-19 pandemic, vaccine conspiracies theories worsen the hesitancy. However, local studies looking on this relationship towards vaccine hesitancy using Malay language validated tools were scarce.

Objectives: This study aimed, firstly to translate and validate One-dimensional Knowledge scale (OKS), Vaccine Conspiracy Beliefs scale (VCBS) and Modified Vaccine Hesitancy scale (MVHS) into Malay language and secondly, to model relationship of demographic variables, knowledge, and conspiracy belief on childhood vaccine hesitancy among parents in Kelantan using structural equation modelling.

Methodology: This was a cross-sectional study conducted in two phases. Phase I, involved translation of the OKS, VCBS and MVHS into Malay version, from April 2023 till June 2023. The scales were translated into Malay based on established guidelines. Content and face validity were assessed involving six expert panels and 10 parents respectively. The data was analysed using Microsoft Excel 365. Then, Phase II was continued between July 2023 till March 2024 involving 270 parents with children aged ≤ 7 years. Confirmatory Factor Analysis (CFA) was used to ensure the scales used were valid and reliable to measure the study variables, then, structural equation modelling (SEM) was performed to determine the relationship between

variables. Test-retest reliability was determined to ensure stability of newly translated scales. Data was analysed using IBM SPSS version 26 and Mplus version 8.

Results: Phase 1, the M-OKS, M-VCBS and M-MVHS achieved recommended scores of ≥ 0.83 for item indices and scale indices for content and face validity indices. Phase II, the measurement model of M-OKS, consist of unidimensional 10-items demonstrated good model fit (CFI= 0.976, TLI= 0.969, RMSEA (90%CI) = 0.053 (0.030, 0.074), WRMR = 0.877). The 8-item of M-VCBS with correlated items showed good model fit (CFI= 0.977, TLI= 0.967, RMSEA (90% CI) = 0.053 (0.020, 0.082), SRMR = 0.028). The 9-item of M-MVHS consist of two domain "Lack of confidence" and "Risk perception" incorporating correlated items achieved good model fitness (CFI= 0.970, TLI= 0.957, RMSEA (90% CI) = 0.057 (0.031, 0.082), SRMR= 0.031). Composite reliability for M-OKS, M-VCBS and M-MVHS ranged from 0.741 to 0.935 and AVE values of ≥ 0.5, indicating all scales demonstrated good convergent validity. The test-retest reliability, measured by the Intra-class Correlation Coefficient (ICC) ranged from 0.730 to 0.854, indicating good stability for all scales. The final structural model consist of ten hypotheses exhibits good model fit based on the fit indices (CFI= 0.961, TLI= 0.954, RMSEA (90% CI) = 0.040 (0.032, 0.053), SRMR= 0.043). Several indirect relationships were identified between pathways towards vaccine hesitancy.

Conclusion: This study provides valid and reliable Malay-language tools to measure knowledge and conspiracy beliefs on childhood vaccine hesitancy among parents in Kelantan. The present study demonstrated the significant relationship of knowledge and conspiracy beliefs on parental vaccination decision, offering valuable insights for

public health authorities and policy maker to devise targeted strategies in increasing vaccination uptake.

KEYWORDS: Vaccine hesitancy, knowledge, vaccine conspiracy beliefs, confirmatory factor analysis, structural equation modelling

CHAPTER 1

INTRODUCTION

1.1 Study background

Vaccines have been identified as the most cost-effective public health measure in preventing infectious diseases among children, saving millions of lives every year (UNICEF, 2018). Vaccines work by stimulating the immune system to generate immunological response which closely resembles the one triggered by a natural infection. However, antigen in the vaccines does not expose the recipient to the disease and its complications (Wodi & Morelli, 2021, p. 3). Over the past two centuries, vaccines have made tremendous progress in reducing morbidity and mortality from vaccine-preventable diseases (VPDs), as evidenced by successful eradication of smallpox and near-elimination of polio worldwide (WHO, 2021a). To date, World Health Organization (WHO) has identified more than 20 life-threatening diseases that can now be prevented by vaccines (WHO, 2019c).

Despite this success, global health data reported that more than one million children still die each year from VPDs, and countries continue to face an unprecedented resurgence of vaccine preventable diseases (Hotez, 2019; Institute for Health Metrics and Evaluation (IHME), 2020). Besides, evidence was noted a decline in measles, mumps and rubella (MMR) vaccines coverage starting in 2015 and accompanied by endemic transmission of measles during 2017 and 2018 (Patel *et al.*, 2019). This threat continuously present until early 2019, witnessing a significant surge in global meases cases, with a 300% increase compared to same timeframe in 2018. This led to more than 200,00 measles deaths worldwide, representing an increase of more than 50% compared to 2016 (WHO, 2019a). These spikes of measles outbreaks occurred in 170 countries, including the region of America, which lost their

elimination status verified in 2016 (WHO, 2020). Additionally, polio which had been reduced by 99.9% since 1988, has reemerged in multiple countries, causing paralysis in 1,100 children (The Lancet, 2022). Furthermore, the global polio immunisation rates also were decreased to 80%, marking the lowest rate in the past 14 years.

Both diseases are highly infectious and have a devastating impact on child health. Measles infections, for instances, can result in prolong immunosuppression in children, predisposing them to secondary infections and malnutrition (Mina *et al.*, 2015). As for polio, 1 in 200 infections causes irreversible paralysis and approximately 5-10% of the paralysed children may experience paralysis of respiratory muscles, leading to death (WHO, 2023). Therefore, in response to this alarming trend, countries have conducted evaluations on the routine immunization programs and have identified vaccine hesitancy as one of critical factors contributing to reduce vaccine uptake and exacerbating the aforementioned conditions (Patel *et al.*, 2019). The doubts about vaccine safety coupled with limited knowledge about the importance of vaccination and low risk perception towards VPDs have been spotted to influence the vaccine uptake (Facciolà *et al.*, 2019; Feemster, 2019). Recognizing the gravity of this issue, WHO has listed vaccine hesitancy as one of its foremost global priorities in 2019 (WHO, 2019b).

In late 2019, a new outbreak of the novel coronavirus (COVID-19) in Wuhan, China has further compounded the challenges that already facing by global vaccination efforts. There has been further drop in global immunization coverage due to services interruptions including vaccination services and the diversion of resources to manage COVID-19 crisis. Moreover, pandemic also has been accompanied by a massive infodemic surrounding the development of COVID-19 vaccine which played a role in denting confidence towards vaccination (UNICEF, 2023). In this situation, along with

accurate information, misinformation and rumours also appear on the scene and much of this misinformation is based on conspiracy theories. Consequently, the spread of this misinformation significantly affect the confidence of the parents towards other vaccines as well including routine vaccines for their children (Olusanya *et al.*, 2021; UNICEF, 2022). A study by Derdemezis *et al.* (2022) among parents in Greece revealed that, mistrust in authorities and controversies surrounding the COVID-19 vaccination have undermined confidence in the governments, led to varying levels of vaccine acceptance in established routine childhood immunization program. This evidence was further supported by a study conducted by He *et al.* (2022), which reported a significant increase in hesitancy towards routine childhood vaccines during the pandemic, driven by heightened risk perception among parents regarding vaccine safety. Similarly, Grills and Wagner (2023) discovered that parents with low COVID-19 vaccination rates also exhibit a notable shift towards more pessimistic perspectives on the effectiveness of childhood vaccines. In essence, the emergence of COVID-19 has exacerbated challenges related to childhood vaccine hesitancy, highlighting the urgent need for comprehensive strategies to address misinformation and rebuild trust in childhood vaccines.

Looking at the complexities of vaccine hesitancy which exacerbates by infodemic of misinformation highlights the crucial role of vaccination knowledge in parental decision-making (Padhi *et al.*, 2022; Shahani *et al.*, 2022). Lack of vaccination knowledge among parents can interfere their ability to extract essential information such as understanding the benefits of vaccines and the severity of VPDs. This can render parents more susceptible to misinformation, thereby amplify the risks perception associated with vaccines (Toure *et al.*, 2014). Therefore, promoting accurate and accessible information about vaccines is essential for countering

misinformation and also for empowering parents to make informed vaccination decisions about their child's vaccination.

1.2 Childhood vaccine hesitancy among parents

The events described above have demonstrated that parental vaccine hesitancy has emerged as a significant public health concern. Previous studies assessing vaccine hesitancy among parents on routine childhood vaccination have shown that its magnitude varies globally. The highest prevalence was reported in European region, with 34.7% in Italy (Napolitano *et al.*, 2018) and another study in Italy by Bertoncello *et al.* (2020) showed comparable prevalence of 32.4%. Conversely, other part of European region like Turkey and Switzerland reported lower prevalence with 11.8% and 23% respectively (Yörük & Güler, 2021; Jafflin *et al.*, 2022). Similarly, variability in prevalence of parental vaccine hesitancy in American region also noted with 6.1% in USA (Kempe *et al.*, 2020), 11.5% in Argentina (Gentile *et al.*, 2021) and 32.2% in Canada (Guay *et al.*, 2019). Meanwhile, the prevalence of vaccine hesitancy among parents in Mediterranean region such as Saudi Arabia revealed value of 24.3%. (Aldakhil *et al.*, 2021). In Western Pacific region such as China, identified prevalence of 20.8% (Wagner *et al.*, 2021). In Malaysia, the prevalence of parental vaccine hesitancy ranged from 4.9% to 11.6% (Fatin Shaheera *et al.*, 2017; Voo *et al.*, 2021; IPH, 2023). Considering the varying degrees of prevalence with disparities observed across different geographical areas, understanding the concept of vaccine hesitancy is crucial.

Vaccine hesitancy is relatively new term in discussion about vaccination which challenges the previous perspectives that only highlight the individual attitudes and behaviours towards vaccination are only a matter of accept all the vaccines or refuse

all vaccines. The recognition of this term has notably increased in publication since 2010 (Larson *et al.*, 2022), with a peak observed after 2015 which mostly contributed by studies from high income countries (Sweileh, 2020). The term vaccine hesitancy seems to be more accurate and inclusive in describing the phenomenon related to attitude and behaviour toward vaccination. It has been defined as presence of doubt or indecision towards vaccination which placed the hesitant parent on a continuum between complete acceptance to complete refusal of vaccines, despite the availability of immunization services (WHO, 2014; MacDonald *et al.*, 2015). This continuum demonstrating various degree or levels of concerns whereby the parents may reject but unsure, selectively accept some vaccines or tend to delay or refuse specific vaccines or even if they accept all the vaccines, they still have some doubts and concern on the vaccination as illustrated in Figure 1.1. Therefore, in understanding vaccine hesitancy, recognition vaccine hesitancy as continuum rather than dichotomy (either accept or reject vaccine) provides better representation. Besides, this continuum allows more detailed strategies can be conducted to improve vaccination uptakes.

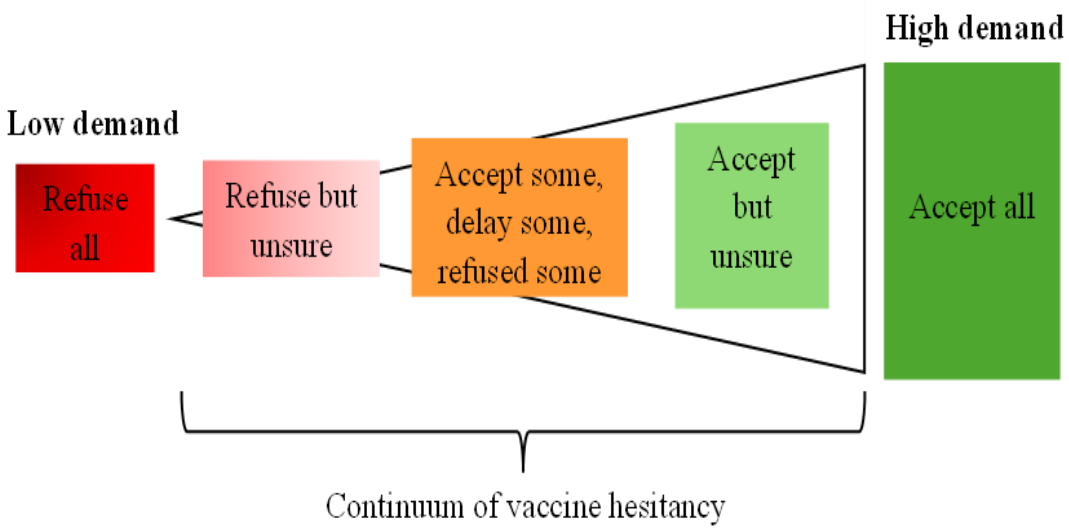

Figure 1.1 The continuum of vaccine hesitancy (Source: WHO, 2014)

Historically, phenomenon of vaccine hesitancy or previously described as vaccine refusal or vaccine resistance has been documented since the introduction of smallpox vaccine in Western countries, where people questioned and had suspicions regarding the motives behind the efforts of smallpox vaccine (Callender, 2016). Besides, as the European nation mandate the vaccine to all infants with penalties to non-compliance, this led to formation of anti-vaccine movements in societies to protest the law, as some individuals saw the mandatory vaccination law as an undue infringement on individual liberty. Nonetheless, the anti-vaccine movements did not end there. With the development of newer vaccines such as polio, diphtheria, tetanus and pertussis (DTaP) and MMR, triggered the expansion of vaccine related controversies (Pennington, 2021). These controversies and debates have continued over time, contributing to the ongoing resistance towards vaccine uptake (Nuwarda *et al.*, 2022).

Vaccine controversies mainly originated from claims of adverse events following immunization. Up to this point, the most famous studies in scientific history, which was published in The Lancet by Andrew Wakefield in 1998, proposed a potential link between MMR vaccine and autism. However, this paper has been retracted since the researcher violated ethical rules in basic research. Despite the retraction, members of anti-vaccine movements continue to cite this study as an argument to challenge the effectiveness of vaccination. The proliferation of anti-vaccine movements which continues to gain momentum and actively disseminating their viewpoints about vaccines, has led to increasing vaccine resistance. Thus, negative impact of anti-vaccine movements is frequently cited as one of the major contributions for rising vaccine hesitancy worldwide (Dubé *et al.*, 2015).

During the last decade, considerable research efforts have been directed towards identifying its determinants. Regard to this issue, the Strategic Advisory Group of Experts (SAGE) on immunization outlined the 3Cs (Confidence, Complacency and Convenience) model, focusing on complacency (perceived vaccine preventable diseases and vaccination as low risk and not important), confidence (lack of confidence on vaccine safety and effectiveness) and lastly convenience (availability and accessibility of the vaccines) as key determinants of vaccine hesitancy (WHO, 2014). However, after much discussion, the group found many factors influence vaccine hesitancy, and there were no simple universal or small groups of determinants can determine the hesitancy in all circumstances and not all interventions works well at all the times (Oduwole *et al.*, 2019). Thus, the group suggested "Model Working Group Determinants Matrix of Vaccine Hesitancy" which cover broader aspect of potential factors that influenced vaccine hesitancy. This model was organised into three key factors: 1) contextual influences which covers mainly on the external factors such as religion, culture, socioeconomic and political, 2) Individual and group influences are factors that affect vaccine hesitancy at both personal level and within the circle communities and 3) vaccine and vaccination specific issues encompass various aspect such as vaccine safety, efficacy, accessibility and trust in vaccination process. Based on review conducted by Lane *et al.* (2018), more than 90% countries across the globe reported on vaccine hesitancy and the cited reasons were long and covered mostly categories on the determinants matrix, but the cited reasons varied by countries. Therefore, inferencing the previous studies from one setting to another might be problematic or should be done cautiously, Hence, to better understand the vaccine hesitancy drivers, it is better to understand in specific contexts.

In investigating childhood vaccine hesitancy, it is important to have in mind the tools that can be used to measure the vaccine hesitancy, either developing new tool or used readily available tools. If opted for readily available tools, it should have strong psychometric properties and validated to reflect the vaccination attitude and behaviour. Based on review conducted by Oduwole *et al.* (2022), there were 26 tools which used to measure vaccine hesitancy. Out of 26 tools, only three tools that interesting to be considered which are Parents Attitudes about Childhood Vaccines (PACV) survey, Global Vaccine Confidence Index and Vaccine Hesitancy Scale (VHS). PACV is the earliest tool developed by Opel *et al.* (2011) consist of 15 items after validation and has three domains: Safety and efficacy, general attitudes and behaviour. This tool is most widely used and has been translated to various languages and validated in multiple setting (Haizlene *et al.*, 2020; Olarewaju *et al.*, 2021; ElSayed *et al.*, 2022). As for Global Vaccine Confidence Index, developed by Larson *et al.* (2016) provide global insights on vaccination attitudes through a 67-country survey based on 4-item scale. Even though these two tools showed good psychometric properties, they have been criticized because only conceptualised based on confidence construct. On the other hand, the VHS which has been developed by the SAGE team based on 3Cs model provides more precision and comprehensive framework in measuring vaccine hesitancy among parents. It has been validated and evaluated in several studies (Domek *et al.*, 2018; Shapiro *et al.*, 2018). However, further adaptation and validation of VHS on different settings are warranted to facilitate meaningful comparisons.

1.3 Childhood vaccination and related issues in Malaysia

Ministry of Health (MOH), Malaysia introduced the National Immunization Program (NIP) in the early 1950s into child health services, starting with the smallpox vaccine (Faridah, 2017). The program was designed based on the WHO Expanded Program on Immunization (EPI), which recommended all countries to immunize against six childhood diseases (Shen *et al.*, 2014). Over the years, the program expanded and now includes immunization against 13 major childhood diseases as illustrated in Figure 1.2 (MOH, 2023). These diseases include tuberculosis, diphtheria, tetanus, pertussis, polio, Haemophilus influenza type B (HiB), Hepatitis B, Human Papillomavirus, measles, mumps, rubella, Japanese encephalitis (JE) and the latest, pneumococcal diseases. The diseases listed are common diseases in the country and around the world which may lead to severe complications or fatal to the infected children, especially among the unvaccinated. Under NIP, the vaccines are provided for free of charge to Malaysian children at all government health clinics throughout the country, while non-Malaysians may receive them at a minimal fee. In addition, the type of vaccines and date of administration of the vaccines to the children are recorded in the Child Health Record Book with the copy version were kept in health clinics for monitoring of the immunization coverage indicator by maternal and child health team at every health clinic. Regular audit is conducted to detect vaccination defaulter (MOH, 2016).

Figure 1.2 Latest immunization schedule updated as August 2023 (Source: MOH, 2023)

The NIP in Malaysia is not mandatory by Malaysian law, yet it has been well received and has contributed to a substantial reduction in child mortality caused by communicable diseases. Since its introduction, the country has achieved immunization coverage of more than 90% as targeted by Global Vaccine Action Plan for all childhood vaccinations in the program (Institute for Public Health (IPH), 2016). Although the immunization coverage exceeded 90%, the VPDs continued to circulate, as evidenced by an increased in number of diphtheria cases. A total of 97 diphtheria cases were recorded between 2016 and 2019 (WHO, 2021b, 2021c). Unfortunately, there have been multiple documented deaths of unvaccinated toddlers as a result of diphtheria. An outbreak of diphtheria in Johor in 2019 was recorded, resulting in a death, which also involved unvaccinated children (Kannan, 2017; MOH, 2017; Tok *et al.*, 2022). Besides, according to Zakiyah *et al.* (2021), a study was conducted to map

the occurrence of pertussis in all states. The results showed that number of cases increased from 248 in 2010 to 888 in 2018. Furthermore, the immunization coverage for the MMR vaccines started to decline below 95% in 2014 (MOH, 2021). Reduction in immunization coverage for MMR has been triggered by misconception about vaccines (MOH, 2015). Parental anxiety over MMR vaccine has persisted due to autism was erroneously linked to MMR. Azreena *et al.* (2018) found that 56.1% of parents believed that immunization cause autism associated with negative attitude towards vaccinations. This decline in coverage coincides with an upsurge in the measles incidence. Starting from 2014, there were upsurge of the incidence of these three diseases as shown in Figure 1.3.

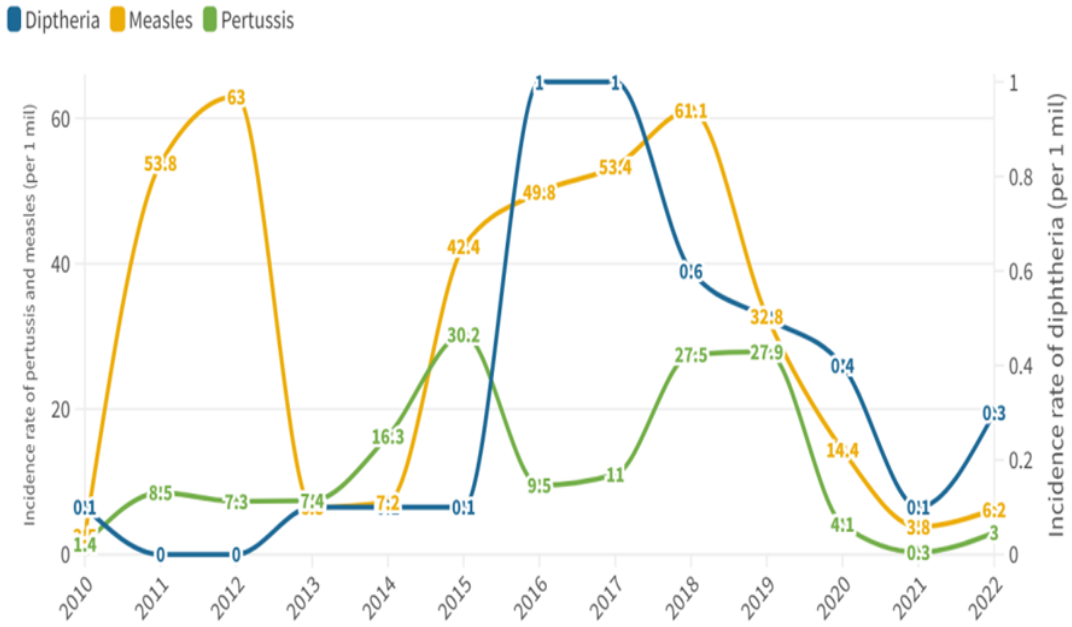

Figure 1.3 Incidence of Diphteria, Measles and Pertussis in Malaysia from 2010 to 2022 (Source: WHO,2023)

The anti-vaccine movement raises various concerns and issues related to vaccines, including conspiracy theories, unfounded claims about side effects, vaccine safety concerns, and doubts about the presence of non-halal ingredients in vaccines (Wan Rohani et al., 2017; Wong et al., 2020; Zaikiah et al., 2020). These concerns are often expressed on social media platforms such as Facebook and YouTube. The spread of misinformation through these channels has led to increased fear among parents who have limited knowledge about vaccines and vaccinations. Moreover, hesitant parents more likely to seek information from the informal platforms, hence they are susceptible to misleading information. The emergence of unvaccinated children can be attributed to the growing spread of misinformation on the social media in recent years as highlighted by the MOH (MOH, 2016). In current era where parents actively seek medical information on their own, they are vulnerable to both misinformation and accurate medical information. Therefore, looking at Figure 1.3, even though the diseases showed reduction, the small upward trend beginning in 2022 is an indicator that the diseases may continue to rise in the future, potentially due to impact media influence on health seeking behaviour.

While national estimates for immunization may indicate adequate coverage, these statistics can be misleading as they may obscure gaps at the local level. The rise in parental vaccine rejection has prompted the Family Health Development Division (FHDD) to begin monitoring data on vaccine refusal for childhood vaccinations since 2014. According to the Ministry of Health (MOH) data, approximately 918 parents refused vaccinations in 2014, and this number increased to 1,541 by 2015(MOH, 2021). The National Health and Morbidity Survey (NHMS) for Maternal and Child Health conducted in 2016 revealed that only 86.5% of children were verified to have completed their primary immunization. An additional 8.9% were self-reported as

vaccinated, while nearly 5% of children were found to be incompletely vaccinated or unvaccinated (IPH, 2016). Following these situations, several initiatives by MOH has been conducted. As for example, the MOH has launched Immunization Campaign in 2016 aimed on correcting the misconception and addressing unfounded claims on vaccination, gathered public support to against anti-vaccine movements and strengthening parents' perceptions, beliefs, and behaviours toward vaccine acceptance. The Ministry also has partnered with the Malaysian Paediatric Association to create the 'Immunise For Life' website, which offers information on vaccine-preventable diseases (Andi Muhammad *et al.*, 2019). However, several improvements regarding the implementation of campaign such as frequency of the campaign since it was only done once for each state and the campaign coverage on attitudes and social norms should be emphasized to improve the acceptance.

Furthermore, a recent nationwide survey in 2022 reported that 83.5% of children had verified primary immunization, with 3.6% being self-reported as vaccinated (IPH, 2023). These findings indicate further decline in the prevalence of completed primary immunization from 95.4% in 2016 to 87.1% in 2022 which warrants more tailored intervention needed. Additionally, statistics from the MOH show that immunization coverage fluctuated between 2010 and 2020 (MOH, 2021).

1.4 Problem statements

Despite the demonstrated effectiveness of childhood vaccines, there is growing concern about issues related to the vaccines that contribute to parental vaccine hesitancy. Global and local estimates showed magnitude of parental vaccine hesitancy ranges from 4.9% to 34.7%. Such levels pose a significant threat in curbing VPDs by impacting herd immunity within the communities. For example, Malaysia has

struggled to achieve measles elimination targets in both 2010 and 2018, but with ongoing measles cases and outbreaks resulting from suboptimal vaccination coverage have necessitated a revised target for 2025. Besides, it is important to note that, although vaccines are freely available in government health clinics and accessibility is facilitated by outreach programs, there are some parents remain concerned about vaccines and tend to delay the vaccination without realising the detrimental consequences. As a result, other highly contagious VPDs, such as pertussis and diphtheria, are increasingly reported in communities especially among pockets of unvaccinated children. Thus, such situation poses as a health threat to the surrounding community and these vaccine hesitant parents continue to jeopardise their children's health if left unattended.

Furthermore, the emergence of the COVID-19 pandemic has intensified the challenges posed by vaccine hesitancy among parents, which was already a significant concern worldwide, including in Malaysia. Although extensively studied, the available evidence published during the pandemic may not fully capture the current impact of COVID-19 pandemic towards child vaccination. Much of the available data was collected years prior to pandemic, thus, potentially underestimating the influence of recent events on parental attitudes and behaviour towards vaccination and may hinder accurate understanding of the current landscape of vaccine hesitancy among parents. This limitation makes it difficult for the public health authorities to implement effective responses.

Additionally, previous studies have emphasized that knowledge about vaccination plays a crucial role in determining vaccination decisions (Mastura *et al.*, 2018; Rosso *et al.*, 2019; Ahmad Faiq *et al.*, 2022). Knowledge encompasses not only factual information regarding the vaccines and their effectiveness, but also include

awareness of the potential risks and benefits associated with vaccination. Nevertheless, in today's digital era, ensuring the accuracy and reliability of such knowledge has become increasingly challenging. This hinders parents from obtaining right and sufficient knowledge and information regarding vaccination. Consequently, inaccurate and insufficient knowledge contributes to a lack of understanding about the importance and benefits of vaccination, thus misleading or deceiving parents.

At present, the internet and social media serve as platforms for disseminating information. However, because these platforms lack the ability to filter the accuracy and reliability of information, the anti-vaccine groups tend to exploit the platforms for disseminating controversial claims based on conspiracies theories. These claims often assert that vaccines and the NIP implemented by government have no benefits and may even have negative effects, thereby undermining parental trust in vaccines. Furthermore, there is a significant portion of the information provided is false or inaccurate, thus fostering unwarranted fears or scepticism towards vaccination. Moreover, the algorithms employed by social media platforms tend to reinforce existing beliefs by predicting and presenting information that aligns with an individual's previous searches, perpetuating the conspiracies belief and ultimately amplifying vaccine hesitancy.

In the context of childhood vaccination, global data has reported that 90% of research on childhood vaccine hesitancy and its determinants mostly contributed among western countries, with very limited studies in the Southeast Asian region, including Malaysia (Sweileh, 2020). Despite recognizing the significant role of knowledge and vaccine conspiracy beliefs in shaping parental decisions towards childhood vaccines, there remains a gap in research that examines the effects and relationships of these determinants on childhood vaccine hesitancy within a single

model. Furthermore, in context of Malaysia, research measuring vaccine hesitancy among parents and its relationship with general knowledge on vaccination and vaccine conspiracy beliefs is still relatively new. Moreover, lack of validated Malay versions of questionnaires with good psychometric properties impedes the effective measurement of these aspects.

1.5 Rationale of study

The uptake of vaccines against vaccine-preventable diseases has had significant positive effects on individual and community health and wellbeing. Notably, an increasing number of parents exhibiting vaccine hesitancy has led to a decline in immunization coverage, resulting in detrimental effects on population health. Recognizing the significance of this issue, WHO has identified vaccine hesitancy as one of the top 10 global health threat (WHO, 2019b). While research on vaccine hesitancy has been extensively conducted globally, it is important to note that vaccine hesitancy is a complex phenomenon and context-specific phenomenon, varying in magnitude across the places. Investigating vaccine hesitancy in Malaysia, particularly in Kelantan, is essential as population in Kelantan might differ in socio-cultural context, which influence various aspect of daily life, including healthcare decisions. Therefore, conducting this study would provide a comprehensive understanding of the issue at the local level and later on could contribute to the development of targeted interventions.

Malaysia also acknowledges the issue of resurgence of vaccine-preventable disease related to vaccine uptake. As a result, it has included this issue as one of the priorities in Malaysia's Health Research Priorities for the 12th Malaysian plan for 2021 to 2025 (Nor Asiah *et al.,* 2021). The knowledge gained by examining the multiple

pathways from this study is highly significant as it will provide an evidence-based groundwork for understanding the framework and evidence of vaccine hesitancy. Since misinformation and conspiracies theories can spread rapidly through various channels, focusing on the connections between knowledge, vaccine conspiracies beliefs, and sociodemographic variables on the vaccine hesitancy allows for the development of targeted interventions to counteract false information and promote accurate knowledge to tackle childhood vaccine hesitancy among parents in Malaysia. Additionally, insights and findings generated from this research can inform tailored educational interventions to enhance public health efforts.

The WHO's Strategic Advisory Group of Experts (SAGE) has recommended to use of the Vaccine Hesitancy Scale (VHS) to standardise the measurement of childhood vaccine hesitancy. They also emphasized the importance of validating the scale to ensure its applicability. In accordance with this recommendation, this study would provide a validated and reliable Malay version of this measurement tool, which can help to identify vaccine hesitant parents at local level. In addition, used of this scale offers researchers, healthcare providers and policy makers a standardised tool to effectively measure the magnitude of vaccine hesitancy among parents. Furthermore, the usage of this tool also contributes to the international comparison, facilitating in understanding broader perspective of vaccine hesitancy trends and patterns.

In addition, this study also focuses on translation of One-Dimensional Knowledge and Vaccine Conspiracy Beliefs questionnaires. Both of these tools are adequately validated instruments, originally developed in Switzerland and Canada, respectively. Therefore, in order to evaluate knowledge of vaccination and vaccine conspiracy beliefs among parents in Malaysia, it is necessary to translate the tools into Malay, as Malay language is the primary language spoken by the general Malaysian

community. Additionally, ensuring language appropriateness is crucial for maintaining the validity and reliability of these scales in future research conducted within the Malaysian context.

1.6 Research Questions

a) Are the Malay versions of Modified Vaccine Hesitancy scale (MVHS), Vaccine Conspiracy Beliefs scale (VCBS) and One-dimensional Knowledge scale (OKS) valid and reliable tools to measure knowledge, vaccine conspiracy beliefs and vaccine hesitancy among parents in Kelantan?

b) What are the relationships between demographic variables, knowledge and conspiracy beliefs on vaccine hesitancy among parents in Kelantan?

1.7 Objectives

1.7.1 General objective

To assess the relationship between demographic variables, knowledge and conspiracy beliefs on childhood vaccine hesitancy among parents in Kelantan.

1.7.2 Specific objectives

1) To translate and validate the Modified Vaccine Hesitancy scale (MVHS), Vaccine Conspiracy Beliefs scale (VCBS) and One-dimensional Knowledge scale into Malay language.
2) To model relationship of demographic variables, knowledge, and conspiracy beliefs on childhood vaccine hesitancy among parents in Kelantan using structural equation modelling.

1.8 Research hypothesis.

- Malay version of Vaccine Conspiracy Belief scale, One-dimensional Knowledge scale and Modified Vaccine Hesitancy scale are valid and reliable instruments to be used among parents in Kelantan.
- There are significant path relationships among sociodemographic variables, vaccine knowledge and vaccine conspiracy beliefs on childhood vaccine hesitancy among parents in Kelantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of existing studies on childhood vaccine hesitancy

Understanding vaccine hesitancy through previous research is essential, given the complexity and context-specific nature of this phenomenon. Numerous studies have been published examining the extent of vaccine hesitancy among different populations. A recent meta-analysis by Abenova *et al.* (2023) revealed that the overall prevalence of vaccine hesitancy among parents of children aged 0-6 years was 21.1%. Given the heterogeneity of vaccine hesitancy, the study proceeds with a subgroup analysis. Analysis based on the income level of different countries revealed that the prevalence of vaccine hesitancy ranged from 3.4% to 41.6% in the lower-middle income countries, from 5% to 34.9% in middle-upper income countries and finally, from 7.7% to 41.4% in high income countries. Additionally, considering the WHO regions, the prevalence of vaccine hesitancy varied from 13.3% in the Regions of Americas to 27.9% in Eastern Mediterranean region. However, no studies included the WHO South-East Asia region due to the limited number of relevant studies.

Apart from differences in the economic levels and regions, the use of various measurement tools to quantify vaccine hesitancy have led to variations in the reported prevalence. Several methods for measuring vaccine hesitancy have been documented in the previous literature (Oduwole *et al.*, 2022). Most studies have utilised the Vaccine Confidence Scale (VCS), Vaccine Hesitancy Scale (VHS) and Parent Attitude about Childhood Vaccines (PACV), which reported prevalences ranging from 6.0% to 38.8% (Gilkey *et al.*, 2016; Fatin Shaheera *et al.*, 2017; Kempe *et al.*, 2020; Aldakhil *et al.*, 2021; Gentile *et al.*, 2021; Helmkamp *et al.*, 2021; Temsah *et al.*, 2021; Wang *et al.*, 2022)

Moreover, the magnitude of vaccine hesitancy also varies locally. The National Health Morbidity Survey (NHMS) , a nationwide survey for maternal and child health conducted in 2022, found a prevalence of 4.9% among the general population (IPH, 2023). Nevertheless, the prevalence observed in this study was comparatively lower than the prevalences reported in certain states, such as Kuala Lumpur, where prevalences ranged from 8% to 11.6% and utilised the PACV as their measurement tools (Fatin Shaheera *et al.*, 2017; Aida *et al.*, 2020). Another study in Sandakan that employed self-designed questionnaire revealed a prevalence of 6.8% (Voo *et al.*, 2021).

In previous research, there were several studies that have not used the term vaccine hesitancy, but rather utilised alternative term such as vaccine non-adherence, vaccine refusal or vaccine defaulter. Nevertheless, these studies included both parents who delay and completely refuse vaccinations. For example, two studies conducted in Kedah reported vaccine non-adherence prevalence of 6.8% of and vaccine refusal of 7% (Sohail *et al.*, 2018; Paramasivam *et al.*, 2019), while, a study using snowballing self-designed survey found a vaccine refusal of 58% (Nurazzura *et al.*, 2019). On the other hand, a study conducted by Lim *et al.* (2016) in Perak found that 18.2% of parents completely refused for vaccination, while 70.5% were classified as vaccine defaulter due to missed appointments but planned to complete the vaccination later. All the subsequent studies mentioned above employed self-designed questionnaires. These variations highlight the impact of different tools and study populations on the reported prevalence.

Vaccine hesitancy is a significant issue that affecting people across all populations. Nevertheless, when it comes to childhood vaccination, parents play a crucial role as the sole decision-makers in health-related decisions for their children.

Understanding their attitudes and concerns towards vaccines is essential for effectively addressing vaccine hesitancy. A bibliometric analysis by Sweileh (2020) sheds light on the research conducted in this area. The analysis revealed that 45.4% of previous studies focussed on assessing vaccine hesitancy among parents. This indicates, recognition of parents as a key population to study, as their decisions directly impact the vaccination status of their children. Furthermore, their decisions not only affect their own families, but have larger implications for community immunity and public health outcomes. In addition to parents, previous studies have explored the role of healthcare providers in addressing vaccine hesitancy as they serve as trusted information sources in shaping attitudes and behaviours of the parents towards vaccination (Ahmad Faiq *et al.*, 2022; Verger *et al.*, 2022). However, focusing on parents provides more direct approach to understand and addressing vaccine hesitancy at the individual and community levels.

In addition to prevalence studies as earlier mentioned, extensive research has concentrated on the determinants of the vaccine hesitancy among parents, using both qualitative and quantitative methods. Majority of studies looked up at the individual type of childhood vaccines such as MMR (Brieger *et al.*, 2017; Périnet *et al.*, 2018), Influenza (Santibanez *et al.*, 2020) and HPV (Siti Nur Farhana *et al.*, 2018; Della Polla *et al.*, 2020; Nguyen *et al.*, 2021). A systematic review by Cella *et al.* (2020) found that the most frequently investigated vaccine was HPV (39.2%), followed by influenza (13.5%), measles (10.8%) and other individual vaccines such as polio, HiB, BCG, rotavirus, Hepatitis B and meningococcal (14.1%). Only 22.4% of articles reviewed investigated childhood vaccination in general. However, the findings from studies exploring on specifics vaccines should not be generalized to all childhood vaccines.

Qualitative studies have identified several main themes surrounding vaccine hesitancy. The themes include parental knowledge, attitudes and beliefs (Fournet *et al.*, 2018; Erchick *et al.*, 2022), concerns on vaccine related issues such as vaccine safety and effectiveness (Blaisdell *et al.*, 2016; Dubé *et al.*, 2016; Wang *et al.*, 2021; Long *et al.*, 2022) and access to information (Sobo *et al.*, 2016; Long *et al.*, 2022). Similar themes have been found in local studies (Rumetta *et al.*, 2020; Wong *et al.*, 2020; Zaikiah *et al.*, 2020; Nur Hazreen *et al.*, 2021).

On the other hands, in the quantitative studies, determinants of vaccine hesitancy have been examined using various questionnaires. Most validated questionnaires are designed based on existing frameworks such as Health Beliefs Model (HBM)(Lau *et al.*, 2013; Kline, 2018; Guay *et al.*, 2019) and Theory Planned Behaviour (TPB)(Harmsen *et al.*, 2012). A systematic reviews by Cella *et al.* (2020) showed that there have been a number of studies that have investigated on the parental knowledge, attitudes, practices and beliefs about childhood vaccinations. Moreover, although research on domains such as knowledge and conspiracy beliefs towards vaccination attitude and behaviour has been conducted in various countries, including Uganda (Vonasek *et al.*, 2016), Italy (Rosso *et al.*, 2019; Bruno *et al.*, 2022), Canada (Périnet *et al.*, 2018; Dubé *et al.*, 2019), Saudi Arabia (Almutairi *et al.*, 2021), United Kingdom (Cookson *et al.*, 2021), United States (Enders *et al.*, 2022), the study remains limited in Malaysia. Based on above studies, a common assumption found that lower level of knowledge and endorsement of vaccine conspiracy beliefs significantly associated with vaccine hesitancy.

As in Malaysian context, there is lack of local data evaluating the influence of knowledge towards vaccination attitude and behaviour. Majority of quantitative studies evaluate levels of knowledge on vaccination (Azreena *et al.*, 2018; Wan Nor

Amalina *et al.*, 2018; Balbir Singh *et al.*, 2019; Norliza *et al.*, 2022; Nur Hafeeza *et al.*, 2022) rather than investigating its association with vaccine hesitancy. An extensive review on the literature found only five studies estimating the relationship between knowledge towards vaccination attitudes and behaviour The overview of these studies is outlined in Table 2.1. Based on these studies, only two studies used the term vaccine hesitancy as their outcome measurement. Meanwhile, with regards to vaccine conspiracy beliefs, no local studies have attempted to assess this relationship towards vaccine hesitancy. Therefore, there is a need to examine relationship of both knowledge and conspiracy belief on vaccine hesitancy among parents in Malaysia.