

DENGUE PREVENTION: CONFIRMATORY FACTOR ANALYSIS OF RELATIONSHIPS BETWEEN ECONOMIC STATUS, KNOWLEDGE, ATTITUDES AND PRACTICE, VACCINE ACCEPTANCE AND WILLINGNESS TO PARTICIPATE IN A STUDY

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Abstract. The aim of this study was to study the relationships between economic status, knowledge, attitude and practice regarding dengue fever (DF), attitude towards vaccination against dengue virus infection, willingness to participate in a study on dengue, and acceptance of a dengue vaccine. Information on variables of interest was collected in questionnaire-assisted interviews during a community-based cross-sectional survey conducted in Aceh, Indonesia. A proposed relationship model was tested using Confirmatory Factor Analysis (CFA), and an Exploratory Factor Analysis (EFA) was used to reconstruct an alternative relationship model among variables. Our proposed relationship model differed from the result of the EFA. The CFA indicated that knowledge and attitudes towards DF had the strongest relationship. We also found several direct relationships between sets of variables: a) economic status and knowledge on DF, b) economic status and practices regarding DF, c) knowledge and practices regarding DF, d) attitudes towards DF and dengue vaccine acceptance, as well as e) attitudes towards vaccination and dengue vaccine acceptance. There was no relationship between economic status and dengue vaccine acceptance. In conclusion, our model suggested that the most suitable factor to be targeted for improving dengue prevention was knowledge about DF. In addition, improving attitudes towards vaccination seemed to be the most appropriate effort to increase public acceptance of a dengue vaccine.

Keywords: confirmatory factor analysis, dengue fever, dengue prevention, dengue vaccine, prevention strategy, vaccine acceptance

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INTRODUCTION

Dengue fever (DF), the most important mosquito-borne viral disease of humans, is endemic in more than 100 countries, and almost half of the world's population lives in DF-risk areas (Murray *et al*, 2013; Guzman and Harris, 2015). Surveys on knowledge, attitudes and practices (KAP) regarding DF in communities have been conducted intensively in some regions (Dhimal *et al*, 2014; Matthias *et al*, 2014; Saied *et al*, 2015; Sayavong *et al*, 2015). Studies on the acceptance of a future dengue vaccine (Hadisoemarto and Castro, 2013) and the willingness to participate (WTP) in a dengue study (Perez-Guerra *et al*, 2012) have been also reported.

Recently, our group conducted a range of DF related studies within the framework of the Aceh Dengue Project. We assessed the KAP on DF, the attitudes towards vaccination, the WTP in a dengue study, and the acceptance of and willingness to pay for a dengue vaccine (Harapan *et al*, 2016a,b,c, 2017). However, the variables were studied separately, and the effects of inter-variable relationships that might exist have not been explored as yet. In a previous study that explored the relationships of four of those variables (economic status and KAP regarding DF), only knowledge about DF had a significant, direct, and positive effect on practice (Castro *et al*, 2013).

To the best of our knowledge, no study is available that has explored the relationships between economic status, KAP, attitudes towards vaccination, WTP, and vaccine acceptance with respect to dengue virus infection, and indeed other infectious diseases. Such an integrative study on the type of interactions among variables (direct and indirect) and the

strength of relationships between variables; however, could be of importance, because it may assist the selection of the most suitable variable to target in an intervention program.

This study therefore aimed to study the relationships among those variables to determine the most suitable variables to be targeted in planned dengue prevention and dengue vaccine introduction programs in Indonesia.

MATERIALS AND METHODS

Study setting

The data used in this study were gathered in the course of a community-based, cross-sectional survey conducted in Aceh Province, northern Sumatra Island, in the westernmost part of the Indonesian archipelago, from November 2014 to March 2015.

Questionnaire

A set of pre-tested questionnaires, adapted from previous studies (Filmer and Pritchett, 1999; Abdullah *et al*, 2013; Hadisoemarto and Castro, 2013; Dhimal *et al*, 2014), was used to guide the interviews with the participants in nine randomly selected regencies of Aceh Province (out of 23 total). The questionnaires covered basic demographic data, economic status, KAP towards DF, attitude towards vaccination, WTP in a dengue study, and acceptance of a dengue vaccine. All items within a domain had a good internal consistency with Cronbach's alpha of minimum 0.7

Study variables

The economic status of participants was measured based on 15 household assets owned. The list of the household assets was published elsewhere (Harapan *et al*, 2017). The ownership of each asset was scored 1.

The knowledge related to signs and symptoms of DF and the transmission of dengue viruses, attitudes towards DF and practices to prevent mosquito-man contact and eliminate mosquito breeding sites were measured using a set of questionnaires comprising 28, 15, and 16 questions (or statements), respectively, that were adapted and modified from previous studies (Abdullah *et al*, 2013; Hadisoemarto and Castro, 2013; Dhimal *et al*, 2014). For the 'knowledge domain,' the possible responses of all questions were 'Yes' or 'No' and a score of 1 was given for each correct answer. The possible responses for each statement within the 'attitude domain' ranged from '1=Strongly Disagree' to '5=Strongly Agree' on a Likert-like scale. For the 'practice domain,' each correct answer was given a score of 1. The scores for the KAP domains ranged from 0-to-28, 15-to-75 and 0-to-16, respectively. Higher scores indicated a better knowledge, a more positive attitude, and a better preventive practice regarding DF.

Attitudes towards vaccination were measured using five statements adopted from a previous study (Hadisoemarto and Castro, 2013). The possible responses to each question were measured on a Likert-like scale ranging from '1=Strongly Disagree' to '5=Strongly Agree,' and therefore the additive score for this domain ranged from 5-to-25.

The WTP in a dengue study was measured by asking participants about their willingness to take part and to allow their family members to take part in a dengue study in case they suffered from dengue virus infection (Harapan *et al*, 2016a). Each question had five possible responses on a Likert-like scale ranging from '1=Very Unlikely' to '5=Very Likely'. Additive scores for the WTP ranged from 2-to-10, where a higher score reflected a better WTP.

The acceptance of a (future) dengue vaccine was measured by asking participants about their willingness to have their children vaccinated (if they had children), in the absence of information related to the dose, administration procedure, or price of that vaccine (Harapan *et al*, 2016, in press). The possible responses on a five-point Likert scale ranged from '1=Very Unlikely' to '5=Very Likely'.

Statistical analysis and approach

First, a relationship model (conceptual model of a variable structure) based on previous studies (Harapan *et al*, 2016a,b,c) was postulated and constructed (Fig 1A). This relationship model was based on the significant association observed on univariate analyses ($p < 0.05$). Then a supervised Confirmatory Factor Analysis (CFA) was used to directly re-test the proposed relationship model. After a correlation matrix had been calculated, model adequacy (chi-square test and goodness-of-fit test) was determined as proposed previously (Castro *et al*, 2013). In addition, an Exploratory Factor Analysis (EFA) with Principal Component Analysis (PCA) was employed to reconstruct an alternative relationship model among variables. All p -values were two-tailed and considered to be statistically significant at the 5% level. All analyses were conducted using R Statistical Software® (R Foundation for Statistical Computing).

Ethical considerations

The Ethical Clearance Committee of the School of Medicine, Syiah Kuala University, Banda Aceh, Indonesia approved this study (269/KE/FK/2014; 2014 Nov 24).

RESULTS

Demographic data

We included 709 participants in the final analysis (Table 1). Seventy percent

Table 1
Demographic characteristics of respondents (N=709).

Variable	No. (%)
Age, mean (\pm SD)	31.16 (10.51)
Sex	
Male	206 (29.1)
Female	503 (70.9)
Education	
Primary school	69 (9.7)
Junior high school	43 (6.1)
Senior high school	252 (35.6)
Diploma 1-3 (associate degree)	147 (20.7)
Bachelor degree or higher	198 (27.9)
Occupation	
Farmer	126 (17.8)
Civil servant	175 (24.7)
Private employee	117 (16.5)
Entrepreneur	139 (19.6)
Unemployed	152 (21.4)
Religion	
Islam	700 (98.7)
Others	9 (1.3)
Marital status	
Unmarried	281 (39.7)
Married	403 (56.9)
Widowed	24 (3.4)
Type of residence	
Suburb	495 (69.8)
City	214 (30.2)
Mean (\pm SD) of economic status (Score 0-15)	8.95 (2.86)
Mean (\pm SD) of knowledge on DF (Score 0-28)	20.40 (3.88)
Mean (\pm SD) of attitude towards DF (Score 1-75)	55.15 (13.58)
Mean (\pm SD) of preventive practice against DF (Score 0-16)	14.00 (4.19)
Mean (\pm SD) of WTP in a dengue study (Score 2-10)	7.09 (2.08)
Mean (\pm SD) of attitude towards vaccination (Score 5-25)	17.42 (4.19)
Mean (\pm SD) of dengue vaccine acceptance (Score 1-5)	4.24 (0.87)

DF, dengue fever; SD, standard deviation; WTP, willingness to participate.

of the participants was female and lived in the suburbs. No illiterate participants were involved. Approximately one-half of the participants had never attended a university. Participants were working as farmers, civil servants, private employees,

and entrepreneurs in approximately equal proportions (18-25%). Twenty-one percent of the participants were unemployed. Ninety-nine percent of the participants were Muslim, and 57% of them were married.

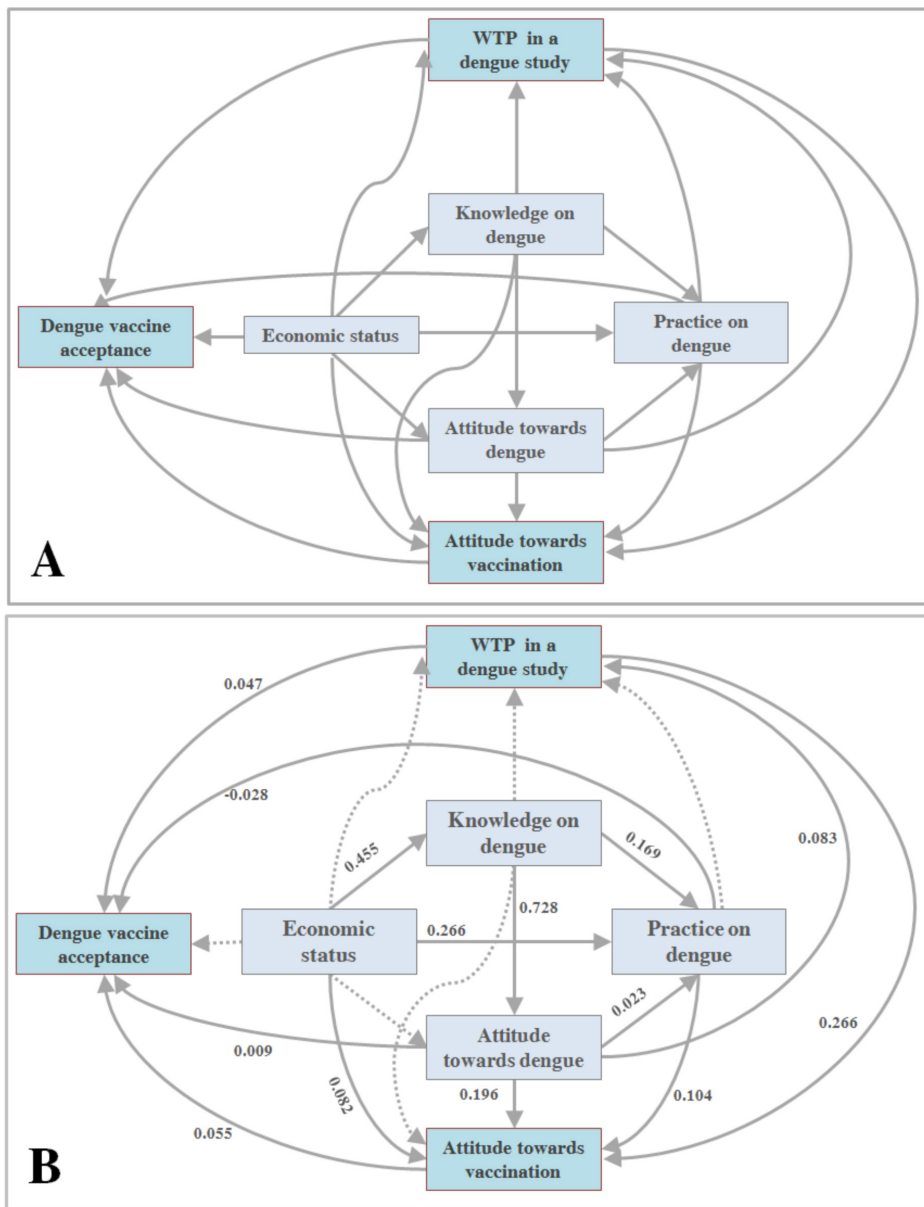


Fig 1–A) Proposed relationship model between economic status, knowledge on dengue fever, attitude towards dengue fever, practice on dengue prevention, willingness to participate (WTP) in a dengue study, attitude towards vaccination and dengue vaccine acceptance. B) Final relationship model based on supervised Confirmatory Factor Analysis.

Confirmatory factor analysis

The results of the CFA are presented in Fig 1B. The CFA model indicated that the most robust relationship existed be-

tween knowledge and attitude regarding DF (estimated value 0.728). This indicated that an increase of 1 point of knowledge about DF (related to the transmission of

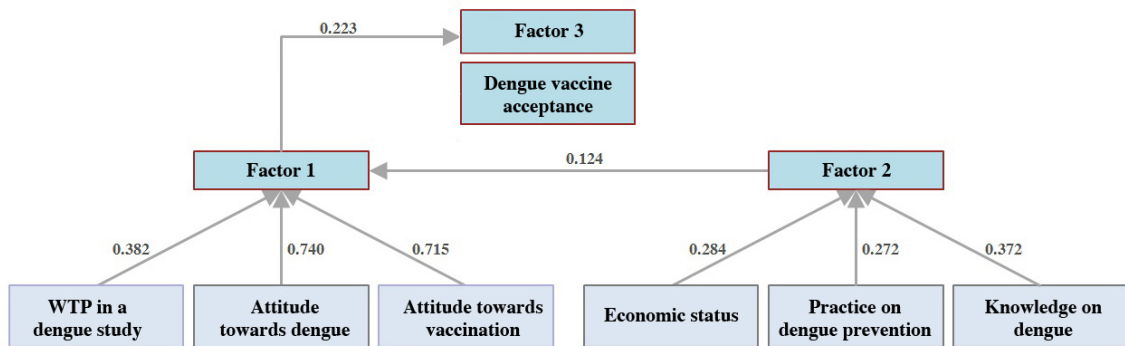


Fig 2—Relationship model using Exploratory Factor Analysis with Principal Component Analysis.

dengue viruses and the signs and symptoms of DF) improves the attitude towards DF by approximately 0.73 points. In addition, there was a direct relationship between economic status and knowledge, economic status and practice, as well as knowledge and practice, with estimated values of 0.455, 0.266, and 0.169, respectively (Fig 1B).

This model also suggested that dengue vaccine acceptance was associated directly (but very weakly) with: a) attitude towards vaccination, b) WTP in a dengue study and c) attitude towards DF, with estimated values of 0.055, 0.047, and 0.009, respectively. This model indicated that the individual factor had only a small effect on dengue vaccine acceptance and, interestingly, that there was no relationship between economic status and dengue vaccine acceptance.

The EFA model indicated that the seven measured variables could be compacted into three factors (eigenvalue >1.0) (Fig 2). Factor 1 combined the variables WTP in a dengue study, attitude towards DF, and attitude towards vaccination. Factor 2 combined the variables economic status, knowledge of dengue virus transmission and signs and symptoms of DF, and practice of preventing mosquito-man

contact and eliminating mosquito breeding sites. Factor 3 well expressed the variable of dengue vaccine acceptance.

DISCUSSION

This study was conducted to study the relationships of economic status, KAP domains, attitude to vaccination, WTP in a dengue study, and acceptance of a vaccine against dengue virus infection. Our analyses indicated strong interrelationships that could be important for designing dengue intervention programs in the future.

There was a direct association between economic status and knowledge as suggested by a previous study (Castro *et al*, 2013). This might be due to people with higher economic status having better access to information on DF through multiple channels (Castro *et al*, 2013). Although the same study found that economic status was not associated with practice (Castro *et al*, 2013), our study suggested a direct association of economic status with practices of preventing mosquito-man contact and eliminating mosquito-breeding sites. We speculated that people with lower economic status (who were mostly working as farmers) spent excessive working time in the farmlands

and therefore did not have enough time to take part in dengue prevention measures (Harapan *et al*, 2016, unpublished data).

In the context of Aceh, dengue prevention measures were associated with leisure activities, such as cleaning the backyards and gardening with family members. In addition, it has been suggested that a low economic status renders people less conscious of environmental health issues (World Commission on Environment and Development, 1987) and, in fact, DF is an environmental disease.

Economic status, knowledge, and attitude towards DF were associated with practice. Among those variables, knowledge and attitude towards DF are two of the factors that are relatively easier to improve compared to economic status. In addition, knowledge had a stronger impact on practice than attitude towards DF (estimated value 0.169 *versus* 0.023) (Fig 1B). This finding is similar to those of a previous study that found only knowledge about DF to have a significant, direct, positive, effect on the practice domain (Castro *et al*, 2013).

To improve the practices of preventing mosquito-man contact and eliminating mosquito breeding sites, efforts to improve the knowledge about how dengue virus spreads and how *Aedes aegypti* breeding sites can be reduced should be put into concrete action through health education activities. Such efforts in conjunction with improving the environmental sanitation and water supply of households and evolving a sustained modification of human behavior belong to the best strategies for the prevention and control of DF in communities (Artwanichakul *et al*, 2012).

Previous studies in the context of DF and other diseases demonstrated that

good knowledge regarding the disease had no association with the acceptance of a vaccine against that disease (Dempsey *et al*, 2006; Jaspers *et al*, 2011; Hadisoemarto and Castro, 2013; Khan *et al*, 2015; Khurana *et al*, 2015; Harapan *et al*, 2016c). In this study, we also confirmed that there was no direct, but an indirect relationship between the knowledge about DF and dengue vaccine acceptance. There was a direct relationship between attitude towards DF and dengue vaccine acceptance as demonstrated by previous studies (Hadisoemarto and Castro, 2013; Harapan *et al*, 2016c). However, compared to attitude towards DF, attitude towards vaccination had a stronger association with dengue vaccine acceptance (Fig 1B).

A pivotal role of attitude towards vaccination on vaccine acceptance was also confirmed in a study with a hypothetical Ebola vaccine (Harapan *et al*, 2016, in press). Taken together, this explains that increasing the understanding of a disease among community members without simultaneously improving their attitude does not improve vaccine acceptance. Therefore, a dengue prevention program should be designed not only to increase the knowledge of the community about dengue but also to improve their attitudes towards DF and dengue vaccination.

A previous study found that a high economic status was associated with a better dengue vaccine acceptance (Harapan *et al*, 2016c), but another study found no such association (Hadisoemarto and Castro, 2013). In non-dengue vaccines, a review found economic status to be inconsistently related to vaccine acceptance in American, African, and Asian countries (Larson *et al*, 2014). Economic status acted as a promoter in some studies while acting as a barrier for vaccine acceptance in others (Larson *et al*, 2014). In addition,

some studies found no association (Hadi-soemarto and Castro, 2013; Khan *et al*, 2015). Our model indicated that there was no direct relationship between economic status and dengue vaccine acceptance.

With respect to WTP in dengue research, a previous study found people who had good knowledge about medical studies (Comis *et al*, 2003) and a good perception and high awareness of medical research (Chu *et al*, 2015) to more likely have a positive WTP in such a study. Earlier, we already demonstrated that a good attitude towards DF was the strongest predictor factor for a good WTP (Harapan *et al*, 2016a). In this study, we confirmed that only the attitude towards DF had a direct relationship with the WTP in dengue research (Fig 1B). Elsewhere, attitude had been found to be positively correlated with the willingness to donate an organ (Afshar *et al*, 2012).

In conclusion, our analyses allowed us to clarify the relationships among variables of interest that had been proposed previously (Harapan *et al*, 2016a, b, c). Using CFA, our final model was able to indicate direct or indirect interactions and the strength of the interrelationships between economic status, KAP on dengue, attitude towards vaccination, WTP in a dengue study, and acceptance of a dengue vaccine. Therefore, this model could be important for determining the most suitable factor(s) to be considered as a target of intervention strategies in a dengue prevention program.

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