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Vulnerability to domestic physical violence among married women in Indonesia

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Abstract

Purpose – Due to the gender norms in Indonesia, married women are vulnerable to domestic violence perpetrated by their husband. With a paucity of studies on this issue, the purpose of this paper is to explore the vulnerability to domestic physical violence among married women in Indonesia by measuring the acceptance of being beaten by their husband and factors associated with married women’s approvals were also identified.

Design/methodology/approach – Secondary data analysis of three rounds of Indonesia Demographic and Health Survey in 2002/2003, 2007 and 2012 was performed. Data were analyzed descriptively to reveal the trend of women’s acceptance and binary logistic regression was applied to identify determinants.

Findings – Women’s acceptance of wife beating in some circumstances experienced an increase during 2002–2012. Determinants varied by type of beating justification. Overall, determinants fell into three groups of women’s, husband’s and household’s characteristics.

Originality/value – This study helps to identify determinants of women’s vulnerability to domestic physical violence and suggests some substantial approaches to address this pressing issue.

Keywords Domestic violence, Physical violence, Wife beating, Married women, Indonesia

Introduction

Violence against a woman perpetrated by her spouse is known as intimate partner violence (IPV) and occurs in several ways, such as physical assaults, threats and intimidation, sexual abuse, and economic deprivation[1]. WHO estimated that the global prevalence of physical and/or sexual IPV among women was almost one-third (30 percent) and the highest prevalence occurred in Eastern Mediterranean and South-East Asian regions, accounting for 37 and 37.7 percent, respectively[2]. In some particular societies, gender norms and cultural practices are at the root of gender-based violence which allows men to use force against women[3]. One of the reasons related to the acceptance of violence
against women, particularly in Sub-Saharan African and South-East Asian societies is associated with patriarchy[4].

Due to Indonesia’s remarkable ethnic diversity and cultural system, the presence of patriarchal norms vary within this country where it can be strongly maintained in some areas whilst it is less possible in other areas. With their influence on family formation, including the preference of a son, patriarchal norms in particular societies can be identified with a tendency toward patrilocal residence and son preference[5, 6]. Patrilocal residence (married couple’s living arrangement in the residence of the husband’s family) predominates in some areas in Indonesia, such as Lampung, the Nias archipelago, Bali, West and East Nusa Tenggara, and eastern parts of Indonesia (Maluku, Papua) where the preference for a son is highly prevalent amongst the ethnicities settled in those areas[6]. The existing and well-maintained patriarchal system impacts on role differentiation and unequal position between men and women in the society and household, leading to discrimination against women[7, 8]. Even if all areas in Indonesia are not patriarchal, the gender inequality in this country is also related to the religious construction of Indonesia as a majority Muslim nation[9, 10].

Even though gender perceptions in Indonesia have started changing, the conservative view is that a woman’s duty is to perform household duties and focus on childbearing responsibilities[11]. As a consequence, a woman is expected to obey her husband in the household, resulting in the increased likelihood that she would be a survivor of domestic violence[12]. In addition, patriarchal norms allow the authoritarian behavior of the husband as acceptable by family members, even if it involves physical violence[13].

A national survey conducted by the Central Bureau of Statistics and Ministry of Woman Empowerment and Child Protection, Indonesia in 2016 found that the prevalence of married women aged 15–64 years old experiencing physical and sexual IPV during their lifetime was 12.3 and 10.6 percent, respectively[14]. However, violence taking place in the family is more likely under-reported in Indonesia since it is viewed as private and not for the public sphere[15]. In addition, other studies conducted in some districts in Indonesia found that both couples’ characteristics were determinants of domestic violence exposure among married women[16, 17].

Physical violence as one of the domestic violence types among married women can contribute to dangerous outcomes in women’s health[18, 19]. A study conducted in a neighboring country, Timor-Leste found that women experiencing physical violence were more likely to report sexually transmitted infections, pregnancy terminations, low birth weight infants and higher rates of child mortality[20]. Therefore, examining the vulnerability to domestic physical violence among married women in Indonesia remains an important issue which can be measured by their acceptance of domestic violence justification perpetrated by the husband. To our knowledge, while some published literature identified determinants of physical violence among women in Indonesia, there is a paucity of scholarly research that attempts to assess women’s approval of being beaten by husbands in Indonesia. This study aimed to describe the trend of women’s acceptance of domestic physical violence and examine the determinants.

Materials and methods

Data
This study was a quantitative study with a cross-sectional approach using secondary data from the standard Indonesia Demographic and Health Survey (IDHS), conducted by Statistics Indonesia, the National Family Planning Board, the Ministry of Health and MEASURE DHS ICF International, Calverton, Maryland USA. The records of individual married women of reproductive age (15–49 years old) were employed from three survey rounds in 2002/2003, 2007 and 2012. Those are current published large data sets of national representations of population-based surveys that help describe the current situation of domestic physical violence among married women in Indonesia. The sampling technique
employed for the IDHS was a multi-stage random sampling, stratified by province, district and village as classified into urban-rural areas[21]. About 91,041 records of individual married women from three rounds of DHS were obtained, of which 902 data sets or almost 1 percent of the total were omitted due to missing values. As a result, only the remaining 90,139 were employed in this study, consisting of 27,544; 30,457; and 32,138 married women were selected from standard IDHS in 2002/2003, 2007 and 2012, respectively.

Variables
The dependent variable was women’s vulnerability to domestic physical violence, measured by their acceptance of domestic violence perpetrated by the husband in five particular circumstances: wife goes out without telling husband; wife neglects the children; wife argues with husband; wife refuses to have sex with husband; and wife burns the food. These five domestic violence justifications are validated measurements that are used globally in standard DHS to measure women’s attitudes toward domestic violence. Five dependent variables were developed from those justifications and a new one was constructed by the acceptance of at least one specified reason. Therefore, a total of six dependent variables were employed in this study. Meanwhile, independent variables for this study fell into three main groups: women’s characteristics: age, educational level, child marriage status; occupational status; husband’s characteristics: age, educational level, occupational status; and household characteristics: number of living children, wealth index, residential type, region. Regarding the wealth index, calculations were made based on household ownership of some selected assets where the data set of the standard DHS classified it into five categories (poorest, poorer, middle, richer and richest).

Statistical analysis
A χ² test was used for bivariate analysis to find out the difference in percentage (prevalence) by independent variables. In addition, binary logistic regression was applied to multivariate analysis to determine the association between independent variables and women’s acceptance with the significant level (α) at 0.05. The results were presented by odds ratio (OR), 95% confidence interval (CI) OR and p-value. Since this study employed national survey data with a complex sampling design, sampling weights and clustering effects were taken into account in order to make sample data representative to the whole population. The DHS data set already provided the weight value, and details of how it works are clearly presented in the DHS guidelines[22].

Results
Table I shows a trend of socio-demographic characteristics of married women, husband and household over a 10-year period. It also reflects the shift in age structure of the actual population due to fertility decline which affects the change in education, and other socio-demographic characteristics. For every 5-year period of the survey, there was a decrease in percentage of young married women (15–24 years old), but the proportion of those aged 30–49 years old experienced an increase, indicating women tend to delay age of marriage, supported by the proportional decline of child marriage prevalence during the course of the decade. In addition, the proportion of women who attended secondary and higher education also increased together with their participation in the labor force.

In a comparison of the couples’ age ranges, the proportion of husbands who were younger or the same age as their wife has been increasing gradually. Similar to the wife’s educational attainment trend, a noticeable increase also occurred among husbands who completed their secondary and post-secondary education. The unemployment status among husbands also decreased gradually.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 27,544</td>
<td>n = 30,457</td>
<td>n = 32,138</td>
<td></td>
</tr>
</tbody>
</table>

**Women**

**Age (years)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>2.64</td>
<td>12.79</td>
<td>18.09</td>
<td>18.62</td>
<td>18.41</td>
<td>15.85</td>
<td>13.60</td>
</tr>
</tbody>
</table>

**Educational attainment**

<table>
<thead>
<tr>
<th></th>
<th>No education</th>
<th>Incompleted primary</th>
<th>Completed primary</th>
<th>Incompleted secondary</th>
<th>Completed secondary</th>
<th>Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/2003</td>
<td>7.46</td>
<td>19.46</td>
<td>34.17</td>
<td>17.60</td>
<td>16.21</td>
<td>5.09</td>
</tr>
<tr>
<td>2012</td>
<td>3.52</td>
<td>12.49</td>
<td>27.08</td>
<td>23.64</td>
<td>23.21</td>
<td>10.05</td>
</tr>
</tbody>
</table>

**Child marriage status**

<table>
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<tr>
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<th>No (≥ 18 years old)</th>
<th>Yes (&lt; 18 years old)</th>
</tr>
</thead>
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<td>2002/2003</td>
<td>57.80</td>
<td>42.20</td>
</tr>
<tr>
<td>2007</td>
<td>63.19</td>
<td>36.81</td>
</tr>
<tr>
<td>2012</td>
<td>68.66</td>
<td>31.34</td>
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</tbody>
</table>

**Occupational status**

<table>
<thead>
<tr>
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<th>Unemployed</th>
<th>Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/2003</td>
<td>48.72</td>
<td>51.28</td>
</tr>
<tr>
<td>2007</td>
<td>40.50</td>
<td>59.50</td>
</tr>
<tr>
<td>2012</td>
<td>36.69</td>
<td>63.31</td>
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</table>

**Husband**

**Age**

<table>
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<tr>
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<th>6–10 years older</th>
<th>&gt; 10 years older</th>
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</thead>
<tbody>
<tr>
<td>2002/2003</td>
<td>12.37</td>
<td>50.64</td>
<td>26.70</td>
<td>10.29</td>
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<tr>
<td>2007</td>
<td>13.36</td>
<td>49.00</td>
<td>27.61</td>
<td>10.03</td>
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</table>

**Educational attainment**

<table>
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<th>Incompleted primary</th>
<th>Completed primary</th>
<th>Incompleted secondary</th>
<th>Completed secondary</th>
<th>Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/2003</td>
<td>4.69</td>
<td>17.79</td>
<td>32.53</td>
<td>17.39</td>
<td>20.66</td>
<td>6.94</td>
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<td>2007</td>
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<td>16.29</td>
<td>29.30</td>
<td>18.96</td>
<td>23.28</td>
<td>8.23</td>
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<tr>
<td>2012</td>
<td>2.46</td>
<td>12.38</td>
<td>26.16</td>
<td>21.39</td>
<td>27.41</td>
<td>10.20</td>
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**Occupational status**

<table>
<thead>
<tr>
<th></th>
<th>Unemployed</th>
<th>Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/2003</td>
<td>3.06</td>
<td>96.94</td>
</tr>
<tr>
<td>2007</td>
<td>2.47</td>
<td>97.53</td>
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<td>2012</td>
<td>1.95</td>
<td>98.05</td>
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</table>

**Household**

**Number of living children**

<table>
<thead>
<tr>
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<th>1–2 children</th>
<th>3–5 children</th>
<th>&gt; 5 children</th>
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<td>2002/2003</td>
<td>7.96</td>
<td>52.40</td>
<td>34.15</td>
<td>5.50</td>
</tr>
<tr>
<td>2007</td>
<td>8.05</td>
<td>56.46</td>
<td>31.25</td>
<td>4.24</td>
</tr>
<tr>
<td>2012</td>
<td>8.09</td>
<td>60.56</td>
<td>28.63</td>
<td>2.73</td>
</tr>
</tbody>
</table>

**Wealth index**

<table>
<thead>
<tr>
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<th>Poorest</th>
<th>Poorer</th>
<th>Middle</th>
<th>Richer</th>
<th>Richest</th>
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<tbody>
<tr>
<td>2007</td>
<td>18.58</td>
<td>20.09</td>
<td>20.51</td>
<td>20.63</td>
<td>20.19</td>
</tr>
<tr>
<td>2012</td>
<td>17.56</td>
<td>19.75</td>
<td>20.58</td>
<td>21.70</td>
<td>20.42</td>
</tr>
</tbody>
</table>

(continued)
During this 10-year period, married couples preferred to have 1–2 children in the household. The socio-economic status within the household improved continuously by a declining proportion of poor households. In addition, an almost similar proportion of those who lived in urban and rural areas were documented. Survey coverage also varied by region where in IDHS 2002/2003, some provinces such as Nanggroe Aceh Darussalam, Maluku, North Maluku and Papua were not included due to conflict and political instability. These four provinces represent 4 percent of the total population[23].

Figure 1 shows married women’s acceptance of domestic violence justification in five different circumstances across surveys. Some examples of justified acceptances of beating experienced an increase whereas the others fluctuated during the course of the decade. The highest acceptance was attributable to “wife neglects the children,” followed by “wife goes out without telling husband” while less than 5 percent of them accepted a beating if they burnt the food. Interestingly, women’s acceptance of at least one specified reason increased sharply by 6.25 percent during the first 5-year period and increased by 2.25 percent for the next period. Overall, one-third (30.14 percent) of women accepted justification for any specified beating during a 10-year period.

Table II presents bivariate analysis of independent variables with each acceptance of domestic violence justification. It also informs proportion (prevalence) differences of all women’s approvals by characteristics of women, husband and household. Based on bivariate

<table>
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<tbody>
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<td>Residential type</td>
<td></td>
<td></td>
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<tr>
<td>Urban</td>
<td>45.71</td>
<td>41.60</td>
<td>49.30</td>
</tr>
<tr>
<td>Rural</td>
<td>54.29</td>
<td>58.40</td>
<td>50.70</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
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<tr>
<td>Java</td>
<td>61.79</td>
<td>61.72</td>
<td>59.69</td>
</tr>
<tr>
<td>Bali and Nusa Tenggara</td>
<td>5.02</td>
<td>5.68</td>
<td>5.40</td>
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<tr>
<td>Sumatera</td>
<td>20.39</td>
<td>17.82</td>
<td>20.26</td>
</tr>
<tr>
<td>Borneo (Kalimantan)</td>
<td>5.76</td>
<td>5.91</td>
<td>5.82</td>
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<tr>
<td>Sulawesi</td>
<td>7.05</td>
<td>6.98</td>
<td>6.65</td>
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<tr>
<td>Maluku and Papua</td>
<td>–</td>
<td>1.90</td>
<td>2.18</td>
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Table I.
<table>
<thead>
<tr>
<th>Variables</th>
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Notes: *p < 0.05; **p < 0.01; ***p < 0.001
analysis using a $\chi^2$ test, almost all women’s characteristics (age, educational level, child marriage status and occupational level) were associated with all acceptances of domestic violence justification. Regarding the husband’s characteristics, while their age and educational level were associated with some women’s approvals, only their educational level was associated significantly with all acceptances. Meanwhile, all variables under household’s characteristics (number of living children, wealth index, residential type and region) were associated with the acceptance of being beaten by their husband in almost all circumstances.

Table III presents six multivariate models of women’s acceptance of each beating justification: model 1 (wife goes out without telling husband); model 2 (wife neglects the children); model 3 (wife argues with husband); model 4 (wife refuses to have sex with husband); model 5 (wife burns the food); and model 6 (at least one specified reason). Based on women’s age, the likelihood of women’s acceptance declined gradually by an increase in the age group, found in all models. A higher educational level affected the more acceptable of physical violence justification in models 1, 2 and 6 whereas an opposite effect was presented in models 3 and 5. Interestingly, almost all models showed that less acceptance was found among higher educated women. Moreover, those experiencing child marriage were more likely to accept several justifications and employed women were more likely to accept almost all beating justifications. Regarding husband’s characteristics, only model 5 showed that women with working husbands were less likely to accept beating justification because of burning the food.

For household factors, having more children increased the likelihood of women’s acceptance. In addition, the better the household economic status (wealth index), the less likely they accepted beating justification. Meanwhile, living in rural areas contributed to increase the likelihood, found in all models. Similarly, those settled outside Java were more likely to accept any justification of domestic physical violence.

Based on model 6, the margin probability of women’s acceptance was calculated by comparing some characteristics of a couple as presented in Figures 2 and 3. According to Figure 2, the highest probability of women’s acceptance was among a couple of a woman aged 15–19 years old while her husband was 6–10 years older; whereas the lowest probability occurred among a combination of a 45–49 year-old woman and a husband who was 10–years older. Regarding educational attainment presented in Figure 3, the probability of acceptance reached a peak among both, the woman and her husband who did not complete secondary education. Interestingly, having a husband who had completed his higher education contributed to lower probability across all educational attainments of a woman. While having a higher educated husband, an uneducated woman, as well as a higher educated one, experienced the lowest probability.

Discussion
This study employed five circumstances of justification for wife beating to measure women’s vulnerability to domestic physical violence. The recorded justifications provide comprehensive and validated measurement and are widely applied for assessing women’s attitudes toward domestic violence. During a 10-year period (2002–2012), several women’s acceptances increased such as “wife goes out without telling husband,” “wife neglects the children,” and “wife refuses to have sex with husband,” resulting in a gradual increase in women’s acceptance of at least one specified reason. A sharp increase by 6.25 percent of at least one reason accepted during the first 5-year period might be due to the survey coverage in 2002/2003 where provinces with political instability were excluded, contributing to fewer women’s opinion regarding this issue being documented. Obviously, conflict and political instability leads to women’s vulnerability to experience domestic or gender-based violence[24, 25].

The patriarchal system and gender norms remain strongly maintained by conservative people in Indonesian society. Not surprisingly, they are internalized since childhood
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<td>0.79–0.91</td>
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<td>0.84** (0.75–0.93)</td>
<td>0.59*** (0.50–0.69)</td>
<td>0.81* (0.67–0.96)</td>
<td>0.54*** (0.42–0.67)</td>
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<td>0.72*** (0.59–0.86)</td>
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<td>1.17** (1.03–1.33)</td>
<td>1.23** (1.07–1.40)</td>
<td>1.26** (1.06–1.49)</td>
<td>1.18** (1.08–1.30)</td>
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<td>Bali, Nusa Tenggara</td>
<td>2.32*** (2.06–2.63)</td>
<td>2.30*** (2.04–2.60)</td>
<td>5.64*** (4.83–6.58)</td>
<td>2.96** (2.53–3.46)</td>
<td>4.29*** (3.47–5.29)</td>
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<td>Sumatera</td>
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<td>F-statistics (df)</td>
<td>21.73 (35; 4812)***</td>
<td>24.04 (33; 4812)***</td>
<td>30.87 (35; 4812)***</td>
<td>14.54 (33; 4812)***</td>
<td>17.14 (35; 4812)***</td>
<td>24.75 (33; 4812)***</td>
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**Notes:** aOR = adjusted odds ratio; CI = confidence interval; df = degree of freedom. *p < 0.05; **p < 0.01; ***p < 0.001
within the family and this practice continues amongst adolescent females during their schooling. As part of the learning process in the school, adolescent females might be exposed to discourse related to gender norms which are integrated into some subjects such as religion, social science and culture. Due to the strong exposure to socially-constructed roles in primary and secondary school, females are more inclined to accept their role as ideal housewife and mother to their children and allow their husband to determine their social life. This might be a reason underlying an increase by...
2.25 percent during 2007–2012 as women’s attendance in secondary school also went up in that period. It aligns with a finding from multivariate analysis showing that those who attended primary and secondary education were more likely to accept some beating justifications for leaving home without informing their partner, neglecting the children, and at least one specified reason. However, no significant difference was found between higher educated women and uneducated women. This indicates that enrollment in primary and secondary education might affect a woman’s attitude and acceptance of her defined role expectations as house worker or mother due to these defined gender roles in school; hence, their acceptance of being beaten for not fulfilling what society expects of them. Nevertheless, women’s acceptance of beating justifications is predicted to fall during the following years in line with the increase by 6.65 percent for the first 5-year period that declined to 2.25 percent for the second 5-year period.

Moreover, those who have the opportunity to continue their studies into post-secondary education enrollment might change their attitudes and disapprove of any justification for domestic physical violence. Similarly, a finding from another study showed that education was negatively associated with violence for women who completed secondary school or higher education only[26]. In addition, Coles and Kotsadam found that the relationship of education and domestic violence is hump-shaped (inverted U) where women who completed their elementary and secondary schooling were more likely to be abused compared to those without education and with post-secondary education[27]. In different circumstances, an increase in educational levels lowers the likelihood of beating justification approval because of arguing with husband and burning the foods. This is consistent with previous studies where those who completed their higher education were more likely to reject domestic violence[28, 29].

In addition to women’s educational attainment, the age of women was identified as a strong determinant of their acceptance. Both of these women’s characteristics remained to show significant effects from the bivariate to the multivariate model which have been controlled for their husband’s and household’s characteristics. This study found that older married women were less likely to accept beating justifications compared to adolescent mothers. In addition, experiencing child marriage contributes to higher levels of acceptance of domestic violence because it leads to economic dependence among married women in the household, driving to low autonomy in decision-making and obedience to their husband[30].

Interestingly, this study found that employed married women were more likely to accept domestic violence. Other studies also showed the same finding where women with income were more likely to be abused more frequently or have relatively higher acceptances of wife beating[1, 27]. This relationship should be interpreted with the caution that the working status among married women cannot represent the various levels of income and whether they earned higher than their spouse. In some cases in Indonesia, even though women are allowed to work by their husbands, their duty as a mother and other domestic workloads were still firmly attached under their sphere of responsibility. In addition, the gender wage gap continues to remain in Indonesia due to gender discrimination resulting in a lower salary earned by females[31]. Due to the double burdens faced by married working women compounded by their lower wage, they are more vulnerable to being domestic physical violence survivors.

The husband’s characteristics turned to be insignificant in multivariate models even if they were significantly associated in the bivariate analysis. Those might not be strong determinants of their partner’s acceptance. Occupational status was the only significant determinant of the husband’s characteristics where employed husbands decreased the women’s acceptance of beating because of burning the foods (model 5). According to margin probability, having a 10-year difference in age or a husband who completed his post-secondary education resulted in the lowest probability of the acceptance of wife beating among married women. Higher educational levels, as well as an increase in age,
may impact on and increase our insight into and increase exposure to the global notion of rejecting partner violence among husbands[32]. Similar to several previous finding, higher education attainment is negatively correlated with being a perpetrator, affecting less acceptance of wife beating[27, 33].

Focusing on household factors, having more children resulted in an increased acceptance of some beating justifications. It may be because having more children increased financial needs[1]. Furthermore, it also impacted on the mother’s opportunity to earn an income by working outside since they needed to take care of their children and perform other unpaid household chores resulting in dependency on the husband and a higher vulnerability to domestic physical violence. In addition, a better socio-economic status of married couples declined the attitude of wives to accept beating justification, found in all models. With the same explanation as resource theory, women in the poorest and poorer household tend to be dependent on their husband, affecting their acceptance of domestic physical violence[28].

Based on the geographical areas, living in a rural area increased women’s acceptance of domestic violence. Living in a rural area is not only related to low socio-economic society, but also because, in rural areas, traditional society has an increased importance in maintaining gender roles, patriarchal norms and cultural values. When patriarchal norms are strongly maintained in a community, the authoritarian behavior of the husband is increasingly accepted[13]. In addition, Benson et al. also argued that more violence in poor communities is related to cultural and institutional reasons[34]. This finding is similar to a previous study in African countries which revealed that living in poorer areas leads to acceptance of wife beating[35]. Based on region, the finding clearly showed that those settled in non-Java regions increased the approval of beating justification. It may be related to socio-economic status at macro level where Java is a more developed region than others. Prevalence of child marriage practice as one of the predictors of women’s acceptance was also found higher in some provinces outside the Java regions[36]. In addition, it might be related to the prevalence that patrilocal residence is predominated in the non-Java regions[6], supported by Rohamman and Johar’s study that married women living in patrilocal communities reduced their physical autonomy[37].

The findings of this study suggest that increasing the opportunity of school enrollment until post-secondary education for girls before getting married is worth considering at community level. It must be followed by developing facilities of accessible and affordable school for secondary and higher education, particularly in rural or less developed areas as well as promoting education as a basic right for females in family. Regarding higher educational levels, it leads women to have more control in decision-making related to themselves and more opportunity to participate in a better paid labor market[37]. In the union, educated women will have more capability to negotiate with their husband in making an informed decision with less dependency on their husband[38]. Furthermore, spending more time in education has the positive result of delaying child marriage as a predictor in this study. In addition, promoting higher education among men is also essential. When both couples complete higher levels of education, it positively impacts on the household economic status, and reduces the likelihood of domestic violence. At the policy level, in an effort to avert child marriage practice, Indonesian Marriage Law No. 1/1974, article 7 paragraph (1) states that the 16 years minimum age of marriage for woman should be revised to be at least 18 years old, following Indonesian Child Protection Law No. 35/2014 and must be enacted equally for both sexes. Revising this law by enactment of the same minimum age of marriage between male and female can also stimulate a positive atmosphere of gender equality in the society.

This study has a number of limitations including the design of the cross-sectional study excluding temporal relationship that could not be examined. Since this study employed
secondary data, it impacts on the restriction of the independent variables such as income level among couples and other social and cultural factors that were not measured. In addition, women’s acceptance of wife beating in this study was only measured by close-ended questions so that the responses were restricted, and also, attitudes toward these accepted practices could not be probed deeply. Therefore, future studies using a qualitative approach are needed to explain this issue.

**Conclusion**
Women’s acceptance of wife beating perpetrated by their husbands experienced an increase during 2002–2012. Several characteristics relating to the married woman, husband, and the household arrangement were significant determinants, and reflecting those factors contribute to women’s vulnerability of being domestic physical violence survivors. Therefore, it is worth considering the option of increasing women’s access to and enrollment on to higher education as a means of empowerment whilst also preventing child marriage practices.

**References**


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Abstract

Purpose – After knee replacement surgery, rehabilitation is needed to recover to normal levels of mobility. A continuous passive motion (CPM) machine is usually introduced at this stage to aid rehabilitation. However, the redundant structure and complex mechanism of the existing machine has resulted in irregular use. The purpose of this paper is to redesign the current machine.

Design/methodology/approach – The mechanical and electrical systems of the current machine were studied alongside interviews with stakeholders. Problems with the existing machine were identified. Related information was gathered in both the engineering and medical aspects. The redesign concept of the equipment was specified following engineering analyses to develop the final model. Finite element analysis was performed to ensure the appropriate size and dimension of the equipment. The prototype of the redesigned CPM was manufactured in-house. Product testing was conducted with 40 volunteers including experienced therapists, nurses, university students and working-age people.

Findings – Compared to the previous machine, the newly designed model was improved in both functioning and manufacturing costs. The redesigned machine is more durable and consists of a less complex structure.

Originality/value – The redesigned machine introduces some new features and removes unnecessary functions. As a result, the model costs less and hence, is considered beneficial to the general public. More utilization is expected which could eventually reduce the therapists’ workload at the hospital. This research provides well-defined processes of the product development starting from the users’ requirement analysis to the prototype testing stage.

Keywords Rehabilitation, Continuous passive motion, Knee replacement, Machine design, Physical therapy

Paper type Research paper

Introduction

Total joint replacement is the removal and replacement of a damaged joint[1]. For example, knee replacement surgery involves replacing the diseased or damaged joint surfaces of the knee (or ends of the bones) with metal and plastic components which together are shaped to allow continuous motion of the knee[2]. In the last decades, total knee replacement (TKR) surgery procedures have continued to increase, with the most pronounced rate among younger patients[3, 4]. Generally, the average age of individuals undergoing TKR has declined. The underlying reason for this trend could be a combination of changes in medical practices as well as increased prevalence of an individuals’ obesity[5, 6]. There is also a significant correlation between GDP and health expenditures with the utilization of the TKR[4]. Not only have the number of operations increased, but also the total cost charges for the procedure have also increased resulting in a significant economic impact on the overall healthcare system. In Thailand, a similar trend has been found. According to data from some national funds.
(i.e. Government Welfare fund, National Health Security Fund and Social Security Fund), the total number of knee replacements have continually increased from 2006 to 2010[7]. The increased lifetime direct costs in the case of TKR procedures can be offset by societal savings from reduced indirect costs (i.e. increased employment and earnings, fewer missed workdays and lower disability payments) and eventually the total net benefit[8]. Nonetheless, to achieve such offset, effective recovery to gain full functional status after surgery is crucial.

After surgery, the orthopedic surgeons or therapists usually discuss the option of an exercise program pertinent to each individual patient. It is necessary for patients to take physical therapy seriously in order to return to their normal condition or as close as possible to it. According to our interview with the head therapist in the orthopedic department at Chulalongkorn hospital Bangkok, the effectiveness of the exercise is largely due to whether the correct posture is achieved during the training sessions. At the same time, from the time of pre-surgery to the recovery phase, patients were reported to have undergone difficult experiences and support from healthcare staff which resulted in negative emotions and discouragement[9]. Hence, patients usually need the help of therapists throughout the recovery process. Compared to the demand of bone and joint cases (i.e. more than 40,000 patients had bone and joint operations or treatments in a year[10]), shortages of physical therapists have become a consistent problem. Moreover, for some patients who use splints, high exertion force is continually required from physical therapists due to the splint weight. To ease such difficulties, the continuous passive motion (CPM) machine was introduced to the orthopedic department at the hospital.

The machine focuses mainly on range-of-motion exercise rather than resistance or functional training which requires different therapies[11]. Unfortunately, its redundant structure and complex mechanism make the existing machine difficult to fix or to perform regular maintenance. As a result, the machine is usually left unused. On the other hand, from the patient viewpoint, it is found that many patients preferred to undergo therapy sessions at home or in their own accommodation rather than visit the hospital. Visiting the healthcare unit on a daily basis undoubtedly requires large amounts of resources from a time and financial perspective. Hence, the situation has resulted in pressure on the medical system to provide more care on an outpatient basis. With professional competence, timeliness, and proper post-surgery care planning, the home healthcare physical therapy system (HHCPT) was shown to be a successful choice when measured against the patient recovery status[12]. A review of over 2,400 patients from 2007 to 2011 also found no difference in terms of pain and knee function two years after surgery between patients who directly went home or those patients who utilized an inpatient rehabilitation facility[13]. Importantly, it is still important to address the patient’s preparations during the discharging process. Five aspects were identified as key checkpoints to consider a patient’s readiness for transferring from hospital to home including physiological and psychological experiences, coping ability, needs from the healthcare team and family support[14].

In light of the existing needs, the aim of this research was to redesign the current machine that involved the improvement of the mechanical and electrical systems. The newly redesigned machine is scoped to address knee movement in flexion and extension directions alone. The underlying reason not to design for a more flexible machine that could be used by various joints is to avoid possible human error. Once the machine is more flexible, it will require better understanding and more attention to operate the machine appropriately whereas operating error is not acceptable in the therapy tasks. For instance, when using a machine with three possible therapy postures, there is a chance that patients recovering from a hip replacement will accidentally do the knee replacement posture, which is extremely harmful. The highest proportion of medical errors was found to be treatment or operation related errors[15]. Possible human errors can be expected as a result of various factors such as caregiver’s fatigue, emotional stress, multitasking demands and communication failure among individuals involved[16]. Therefore, design for only one posture in a machine is considered safer.
Materials and methods

The redesign process consists of three major steps including the study of knee replacement and current therapy, the machine redesign utilizing the engineering process, and prototype development and testing. Details for each step are as followed.

The study of knee replacement and current therapy

People may consider knee replacement surgery if one has a stiff, painful knee that makes it difficult to perform even the simplest of activities. In many cases, the pain is intense both during movement and during rest periods. Knee replacement is a viable solution when other treatments are no longer working and/or to avoid side effects from continuing use of painkillers[17]. Usually, a more affordable and less invasive procedure such as a weight loss program focusing on diet and exercise is preferred by the patient[18]. Although it may take up more than a year, the concrete prevention program overseen by a licensed personal trainer and skilled kinesiologist could successfully improve the TKR candidate’s knee pain symptoms (i.e. reduced body weight, more quadriceps strength) to the point that the surgical intervention could be deferred[19]. Theoretically, the reduction in joint load may play a significant role even though there are no anatomical changes in the knee area. Also, with the advancement of smartphone technology, it is possible nowadays for a telephone-based tracking program to facilitate the patient’s behavior changes[18]. Hence, preventive methods are suggested as an alternative treatment modality, particularly for younger adults. Of note, TKR surgery is typically reserved for people over 50 years of age.

When it is necessary, the surgical process begins with giving the patient a general or spinal/epidural anesthesia. The incision is made across the front of the patient’s knee. The damaged bone and cartilage is then removed from the femur or thighbone. Then, the cut area is resurfaced to shape fit with the artificial joint; the femoral component in this case. Usually, the artificial component (either metal or plastic) gets attached to the bone using cement or a suitable special material. Similar processes are performed with the tibia or shinbone in order to attach the tibial tray. Finally, if necessary, an additional plastic piece will be attached to the patella or kneecap bone and depends on proper fitting of the entire implant. When fit together, the attached artificial parts serve as the new knee joint. The surgeon will bend and flex the knee to ensure proper alignment and position before stitching to close the incision.

The average hospital stay after knee joint replacement is usually three to five days. The pain caused by the damaged joint is usually relieved when the new gliding surface is constructed during surgery. A day after surgery, patients are usually encouraged to perform light physical activities including standing and exercise involving movement around the joint. At first, the patient may walk with the help of parallel bars. Then, a walking device such as a walker or cane will be introduced until the patient’s knee is able to support his/her own body weight. During the recovery period, patients are usually sent home or sent to a rehabilitation facility, depending on the patient’s condition at the time. If patients are sent to a facility, the average rehabilitation stay is approximately seven to ten days. If patients are sent directly home from the hospital, the doctor will usually have a physical therapist assigned to treat patients at home. The doctor also may have patients go to an outpatient physical therapy facility as the final stage of the rehabilitation. Outpatient therapy may last from one to two months, depending on the patient’s.

During the first six weeks of physical therapy, patients should not pivot or twist the operated leg. Additionally, when lying in bed, patients should keep the involved knee as straight as possible. Kneeling and squatting should be avoided soon after knee joint replacement surgery. The physical therapist will provide patients with techniques and adaptive equipment that could help patients. Guidelines and precautions while performing daily activities are usually provided. All techniques are followed to avoid the dislocation of
the patient’s newly replaced joint. Ideally, the patient should exercise two to three times a day, everyday, after surgery. Post-surgery exercise starts with knee bending movements by sliding the heel up toward the buttocks. The heel is kept on the bed. This is flexion movement. Then, the heel is slid back to the starting position for extension movement. A plastic bag can be added under the patient’s heel to help make this sliding easier. Exercising both legs are recommended. Within about six weeks, most people are able to walk comfortably with minimal assistance. Once muscle strength is restored, people who have had knee joint replacement surgery can perform most activities[20].

**Machine redesign**

Machine redesign steps commenced with user requirement analysis to specify machine necessary functions, conceptual design to draft the machine body structure, 3D drawing to illustrate the redesigns, engineering calculations to specify detailed design and finite element analysis to verify the calculated dimension of the equipment. Details are as followed.

**User requirement analysis.** Interviewing and brainstorming with doctors, therapists and nurses were conducted. In general, ease of use is crucial to avoid operating error as much as possible. It is particularly important to note that main users are not only therapists but also a patient’s relatives or caregivers. Therefore, it is most advisable that only two inputs are required from the operator to run the machine, which includes the degree of knee bending and lapse or number of repetitions. The degree of movement range is set up according to each patient’s range-of-motion capability at that time. At the very first day of therapy, patients might not be able to move the joint much but by the last week of therapy, they should be able to bend their knee more than 90° and walk like normal.

After setting the movement range, the operator will be required to input the number of lapses needed (repetition times). Normally, the exercise is arranged in a set of thirty repetitions. Each set is followed by the other during the 30 session. Lastly, for any unpredictable events, an emergency stop button is added to the design. Note also that the emergency button was not available in the previous design.

**Conceptual design.** To specify the body size of the machine, the lower extremity anthropometric data (i.e. thigh length, lower leg length and foot length) is considered and translated into the design range. The design for adjustability concept is selected to accommodate various sizes of patients. Two major adjustable components which are designed in the new model include thigh and footpad ranges. The existing CPM machine is shown in Plate 1.

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**Plate 1.**
Existing CPM machine at Chulalongkorn hospital
3D drawing. The 3D drawings composed of various machine parts were continually introduced. The drawings were essential for enabling effective communication between the design team and the healthcare personnel before making the final changes and refinements. The reverse engineering technique was utilized. This iterative development process was intended to improve the quality and functionality of the design. Eventually, three successive models were created as shown in Figure 1.

Engineering calculations. After the final conceptual design was completed, the important component has to be theoretically calculated by engineering principles and knowledge in order to find the required and verified dimension for the detailed design of all mechanical and electrical systems. Detailed calculations for this stage are explained below.

Knee joint structure
During actual usage, the weight from the patient’s leg is applied directly to the knee joint structure of the CPM machine. This load can be considered as a compressive load onto the bar which has a high tendency of bending failure. Therefore, the mechanics of material principles were used to verify the appropriate bar cross section. The patient’s total leg weight was estimated from 18.94 percent of the total body weight[21]. To ensure that the machine can withstand the extreme weight, the weight data is selected from a large male subject and multiplied by five to set the safety factor. The dimension of the pipe was later selected based on two conditions; the proper size related to its operating condition and whether the size withstands the applied load. Whether the pipe size and specification are available commercially or not was another crucial factor for pipe selection to allow for manufacturing possibility.

The calculation process started from performing force analysis on a simplified 2D free body diagram. The shear and bending moment along the bar were analyzed using a graphical method which results in shear force and bending moment diagrams. The maximum bending moment was then estimated from the diagram. Relevant formulas utilized in this step are Equations (1)-(4) as follows:

\[
\frac{dV}{dx} = -g, \quad (1)
\]
$$\Delta V = -F(F \downarrow \Delta W \downarrow),$$  \hspace{1cm} (2) \hspace{1cm} \text{Redesign of a CPM machine for TKR therapy}

$$\frac{dM}{dx} = V,$$  \hspace{1cm} (3)

$$\Delta M = M_0(Clockwise \rightarrow \Delta M \uparrow),$$  \hspace{1cm} (4)

where $V$ is the shear force, $q$ is load intensity, $F$ is applied normal force, $M$ is bending moment and $x$ is distance.

After that, by knowing the maximum bending moment and moment of inertia for the selected stainless steel pipe, the maximum bending stress was calculated. Relevant formulas for this step include Equations (5) and (6) as follows:

$$I = \frac{\pi D^4}{4},$$  \hspace{1cm} (5)

$$\sigma_{\text{max}} = \frac{M_{\text{max}}C}{I},$$  \hspace{1cm} (6)

where $I$ is the moment of inertia, $D$ is diameter of the circular pipe cross-sectional area, $\sigma_{\text{max}}$ is maximum bending stress, $M_{\text{max}}$ is maximum bending moment and $C$ is the radius of the circular pipe cross-sectional area.

Finally, maximum bending stress was compared with the allowable compressive strength of the selected material.

**Connector**

The connector is one of the most important components connecting with the movable slider. It is a moving component which is used not only to connect the upper and lower section together but also to carry all existing compressive loads when in use. The total compressive load from various parts (i.e. knee joint, patient’s leg, doctor bar, footpad and movable support) is axially and directly applied on the connector. Then, using an Equation (7), the minimum cross-sectional area (and hence, its length) was calculated:

$$A = \frac{P_{\text{max}}}{\sigma_{\text{allowable}}},$$  \hspace{1cm} (7)

where $A$ is the minimum cross-sectional area, $P_{\text{max}}$ is total compressive loads and $\sigma_{\text{allowable}}$ is material compressive strength.

Finally, the following equation was used to verify the designated cross-sectional area and dimension of the connector by considering expected deformation from the applied load:

$$\delta = \frac{PL}{AE},$$  \hspace{1cm} (8)

where $\delta$ is the displacement due to loading force, $P$ is the total compressive loads, $L$ is the connector’s length, $A$ is the connector’s cross-sectional area and $E$ is the modulus of elasticity.

Calculation results show that the displacement is expected to be very low (able to be rounded into zero displacements). Therefore, there is no deformation on the bar.
Ball screw selection

In order to find an appropriate size of the ball screw, the axial load had to be identified. This load can be estimated by using the following equation:

\[ \text{Axial load} = \mu Wg, \]  

(9)

where \( \mu \) is linear bearing friction coefficient, \( W \) is moving mass (i.e. patient’s legs and machine components) and \( g \) is gravitational acceleration.

Then, the selection of the ball screw was made and several parameters were checked to confirm the safety factor. Evaluation utilizing information\[22\] showed that the machine is not performed under high external load and can be considered as acceptable. Equations (10)–(12) were used to confirm this particular step:

\[ L_{10} = \left( \frac{C_a}{F_m} \right)^3, \]  

(10)

where \( L_{10} \) is life performance, \( C_a \) is dynamic carrying capacity of the ball screw, \( F_m \) is mean load:

\[ \eta_c = \frac{49 \times 10^6 f_1 d_2}{l^2} \]  

(11)

where \( \eta_c \) denotes the critical speed of the screw shaft, \( f_1 \) is the mounting correction factor, \( d_2 \) is the root diameter and \( l \) is the distance between support beams. Also, the speed limit (\( \eta x d_0 \)) should not exceed 50,000 rpm:

\[ F_c = \frac{34 \times 10^3 f_3 d_4^4}{l^2} \]  

(12)

where \( F_c \) is buckling strength, \( f_3 \) is the mounting correction factor, \( d_2 \) is the root diameter and \( l \) is the distance between support bearings.

Motor selection. In order to ascertain the suitable size of the motor and its gearhead, the motor is selected based on its application, the drive mechanism. The specification and operation conditions of the drive mechanism are determined from the previous selection of the ball screw. Next, the gear ratio of a gearhead and load torque are calculated. Calculation for this step utilized Equations (13) to (15):

\[ N_G = \frac{V \times 60}{C} \]  

(13)

where \( N_G \) is the speed at gearhead shaft, \( V \) is ball screw speed and \( C \) is the distance moved for one rotation of the ball screw:

\[ T_L = \left( \frac{FP_B + \mu_0 F_0 P_B}{2\pi \eta} \right) \times \frac{1}{i}, \]  

(14)

where \( T_L \) is the load torque, \( F \) is axial load, \( P_B \) is ball screw lead, \( \eta \) is ball screw efficiency, \( \mu_0 \) is internal friction coefficient of preload nut, \( F_0 = (1/3)F, i \) is the gear ratio of mechanism.

Finally, the motor was selected from the Suntech Motor catalogues [23,24] ensuring that it must produce more torque than the load requires:

\[ T_M = \frac{T_L}{i \eta_G}, \]  

(15)

where \( T_M \) is motor torque, \( i \) is gear ratio of mechanism and \( \eta_G \) is gearhead efficiency.
Finite element analysis

Finite element analysis, a reliable computer-aided engineering (CAE) method, is performed to verify the calculated dimension in order to ascertain if it can withstand the expected applied load. The simulation program is used to compute and simulate the stress and displacement analysis of each part of the equipment to verify the structure. The total number of ten parts was tested using this method. Figure 2 illustrates an example of the finite element analysis results.

Prototype development and testing

A prototype of the redesigned CPM was fabricated in-house and used during the interview sessions. Interviews were conducted with 40 people consisting of 22 males and 18 females. Their age ranges varied from 19 to 41 years old. Volunteers for the evaluation sessions included university students, working-age group individuals, experienced therapists and nurses. Some examples from the sessions are shown in Plate 2.

During the session, the volunteer was given information regarding how to use the CPM machine. After allowing time for actual operation, discussion on their opinions toward the machine was held. Volunteers were asked to give their subjective rating on ten performance dimensions using a four-point scale ranging from excellent, good, fair and poor. The ten assessed indexes were aimed to measure the machine’s usability (i.e. ease of use, the level of understanding for pictorial instruction, appropriate and correct commanding), functionality (i.e. smooth operation, noise level, safety usage), and body structure (i.e. aesthetics, size). Overall satisfaction on the redesigned machine was included as the last index.

Results

Plate 3 shows the prototype of the CPM final redesign. The redesigned machine has a simpler structural design and fewer components than the previous model which results in...
easier operation and maintenance processes. By having stronger and more durable structures and mechanisms, the machine can be expected to also last longer.

Additions to this new model are shown in Figure 3 which include a double safety switch, a numerical keypad and counting program and an emergency stop. All these additions are not available in the existing model. The redesigned machine can automatically count lapse numbers and perform a self-stop function rather than stop upon the user’s activation. Arduino IDE software was used for coding the electrical components.

Furthermore, vibration from the driving motor is reduced and the machine operates with lower noise. Production cost is also cheaper than the current machine. At present, the redesigned model sale price is estimated at 100,000 Baht compared to the previous 150,000 Baht.

For evaluation purposes, interviews with volunteers found that 47.5 percent of the responses considered the redesigned machine as “good” regarding performance, 43.3 percent reported “excellent,” and 9.2 percent reported “fair”. There were no “poor” performance ratings in any of the assessed dimensions. Subjective responses collected during the session are summarized in Table I.
Discussion

The redesigned machine is expected to result in more utilization at the hospital. Not only can the CPM machine be used after knee surgery, but the machine is also proposed as a possible movement therapy for early stroke recovery[25, 26]. The machine could also provide movement opportunities for otherwise immobile patients. Obviously, with increasing machine usage, the total workload of the therapists could expect to be reduced while fast progressing therapy for the patient is still possible.

Despite the success of the redesign, there is still room for further improvement as found during the interview sessions. Three major improvement points include pictorial instruction, aesthetics, and ease of use where there are much larger responses of "good" than "excellent," respectively. As illustrated in Figure 3, the control panel is still lacking information transmission such as labels and symbols to indicate the functionality of each control. Future models deserve more attention on the machine interface design in particular. Providing information on the total operating time was also requested by some evaluators because some users may easily lose track of time while performing such a passive repetition of movement. Furthermore, auditory signals should be added when the emergency stop is pressed. From an esthetic point, modification of the machine exterior should be made. Most of the complaints were regarding messy wires that should be kept tidy. For ease of use, it was suggested that the location of the control box should be nearer to the patient to ensure an easier and comfortable reach. Finally, adding the leg's supporter with thicker leg wraps while reducing the total weight of the machine was deemed preferable.

Among all the above suggestions, the machine interface is the most critical, especially if the machine is intended for the market. Once the user understands how to control the redesigned machine (given verbally during interviewing sessions), all functionality dimensions are satisfied. Balancing between interface design (for safety and usability) and aesthetics is a key success factor for medical devices[27] where misuse can result in harmful consequences. The published trending data analysis from the US Food and Drug Administration (FDA) on Medical Device Recalls between FY2010 and FY2015 pointed out that device design is the most prevalent cause of recalls and also the most likely to cause serious health problems to the end user[28]. Problems with design are usually categorized in various aspects such as the design component, label, packaging, etc.
With continued problems that have arisen, it is not surprising that usability related standards and codes are specifically given to the medical device design by various organizations such as Quality System Regulation 21 Code of Federal Regulations part 820 (21 CFR 820)[29], ISO:62366 Usability Engineering to Medical Device[30], and ANSI/AAM HE75:2009[31].

Eventually, with the appropriate design, administration of the redesigned CPM in the home setting could also be enhanced. In reality, not only is the machine design important, but various factors from the patients’ perspective also play a crucial role in the patient’s compliance with the home-based exercise regimen. These factors include the ability to accommodate exercise within everyday life, the opportunity to multi-task therapy with recreational activities, perceived severity of symptoms, attitude and self-motivation[32]. Therefore, a well-designed machine needs to be provided accompanied by person-specific advice from health-related personnel to ensure the overall effectiveness of the therapy session.

Conclusion
The redesigned machine has followed the product development process. Having no background in medical related knowledge, the design team had to spend some time gaining knowledge of knee replacement procedures and therapy. Thereafter, the redesign process was performed starting from user requirement analysis to specify current problems which assist in coming up with the conceptual design of the machine. The 3D drawing, engineering calculations, and finite element analysis were later carried out. After theoretical confirmation of the design had been made, the prototype was created and tested with volunteers. In conclusion, the redesigned model serves its objective to reduce complex and unnecessary functions. There are several advantages resulting from the simpler design of structure and mechanism which are as follows:

1. decreased weight owing to fewer included structures;
2. lower material and manufacturing costs;
3. reduced points of maintenance;
4. the machine’s ability to automatically count the number of lapses and stops; and
5. reduced vibration from the driving motor.

The proposed improvement of the machine is summarized and discussed. The most critical shortcoming is the lack of visual information on the machine to allow decent usability. Standards and codes will need to be reviewed and followed accordingly when the machine is intended to be on the market.

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Sleep quality among industrial workers: related factors and impact

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Abstract

Purpose – The purpose of this paper is to explore the prevalence and determinants of poor sleep quality among industrial workers in Thailand. Additionally, the authors assess the risk of work-related injuries associated with poor sleep quality.

Design/methodology/approach – A descriptive correlational research was implemented. A total of 472 workers from the northern region of Thailand contributed to this study. Sleep quality was assessed by the Thai version of the Pittsburgh Sleep Quality Index (Thai-PSQI). The score of more than five indicated poor sleep quality. Participants completed self-administered demographic, work characteristics and work-related injury questionnaires. Data were analyzed by applying descriptive and logistic regression statistical techniques.

Findings – More than one-third of the workers had reported poor sleep quality. Results from multivariable logistic regression analysis yielded male gender (OR = 2.74, 95% CI 1.46–5.17), alcohol drinking (OR = 2.1, 95% CI 1.24–3.35), pain (OR = 2.05, 95% CI 1.32–3.17) and rotating shift work (OR = 1.94, 95% CI 1.23–3.05) increased the risk of poor sleep quality. Furthermore, poor sleep quality was statistically significantly associated with the risk of work-related injuries (OR = 3.98, 95% CI = 2.39–6.66).

Originality/value – Findings of this study indicate that the prevalence of poor sleep quality is high among industrial workers. Work characteristics and health behaviors were associated with poor sleep quality which increases the risk of work-related injuries. Modification of work environment and personal life style choices can improve quality of sleep among workers and consequently lower incidence of work-related injuries.

Keywords Sleep quality, Industrial worker

Paper type Research paper

Introduction

Sleep quality is the tenet of good health and economic productivity. Poor sleep quality increases the rate of accidents, work-related errors and absenteeism and reduces overall work performance. Additionally, poor sleep quality is associated with the decline of personal relationships and increases the overall rate of premature mortality[1–7].

Sleep quality is influenced by an array of factors ranging from demographic characteristics, to personal life style choices to type of work and condition of work environment[8]. Advanced age, unmarried status, smoking habit and alcohol consumption have been reported to compromise quality of sleep[8–11]. Among the workforce, work-related physical fatigue and rotating shift work and personal coping capacity have been reported to influence the quality of sleep [9,11–13].

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Sleep disturbances, in the longer term, affect the safety and health of workers. Sleep problems such as obstructive sleep apnea, excessive daytime sleepiness, and sleep debts are associated to accidents or near-miss accidents[14]. In addition, the National Health Interview Survey revealed that short sleep duration (less than 6 h) increased risk of injuries[15]. A study of cases admitted to hospital due to a moderate to severe work injury indicated that poor sleep quality which resulted from short sleep duration or long duration of working was related to work injury of any type[16].

In Thailand, research on sleep quality, primarily, has been focused on hospitalized patients and hospital staff, i.e. nurses[17–21]. There is a paucity of such research among industrial workers in Thailand. Our review of medical and scientific literature yielded only two studies on sleep quality among Thai industrial workers[5, 22]. We conducted a study with the objective of assessing the prevalence of and risk factors for poor quality of sleep and its impact on work-related injuries.

Materials and methods

Study design and sample size
A descriptive correlational research was implemented. Study participants consisted of employees working in three large factories in the northern region, Thailand. Sample size was calculated based on findings by Chol et al.[8]. Similarly, we included 14 variables in our sample size calculation, using G* Power statistical package. Our calculation yielded a sample size of 393 with the statistical power of 80 percent at 0.05 statistical significance. Finally, we inflated the sample size by 20 percent (n = 475) to allow for drop outs and/or incomplete questionnaires.

Research ethics
The research study was approved by the Research Ethic Committee of the Faculty of Nursing, Chiang Mai University (ref: no. 145/2015). Participants signed informed consents and confidentiality of their information was protected.

Data collection
Large factories in the Northern region of Thailand were contacted and asked permission for data collection. Three factories agreed to participate in the survey. A self-reported questionnaire was distributed to industrial workers who met the inclusion criteria: aged 18 years and older; able to read in the Thai language; full-time working and having experience on working at industrial setting at least one month.

We designed a self-administered questionnaire to collect information about demographic and life style characteristics, quality of sleep and work-related injuries. Participants were asked to provide information about their age at the time of participation in the study, gender, marital status, education level, smoking and alcohol consumption habits, exercise, pain, body weight and height, year of working experience, job satisfaction and shift work.

Sleep quality was measured by the Thai version of the Pittsburgh Sleep Quality Index (Thai-PSQI). Information about the Thai-PSQI has been published previously[23]. It is a standardized self-reported questionnaire that measures the overall sleep quality over a period of one month. Thai-PSQI contains 19 self-rated questions grouped into seven categories: sleep duration, sleep disturbances, sleep latency, daytime dysfunction, habitual sleep efficiency, subjective sleep quality and use of sleep medications. Each component is scored from 0 to 3, yielding a global PSQI score between 0 and 21. A score more than five categorizes quality of sleep as poor[24].

We developed work-related injury questionnaire to assess the injury experiences during the year before the survey. Responses were dichotomized into “Yes” or “No.” The Thai-PSQI questionnaire was piloted among the workers. The reliability of our instrument was assessed by using Cronbach’s $\alpha$ statistics ($\alpha = 0.85$).
Descriptive statistics were used to summarize demographic, sleep quality and work-related injuries. The variable age at the time of participation in the study was dichotomized into younger than age 45 and age 45 or older. Participants were classified based on their education level into “Less than College” or “At Least 4-Year of College.” For the variable years of work experience, we opted to classify the study participants into two groups, “Less than or equal 5-Year of Work Experience” and “More than 5-Year of Work Experience.” Body mass index (BMI) was calculated using the formula: weight (kg)/[height (m)]² and was dichotomized as 18.5 ≤ BMI ≤ 22.9 or normal and BMI ≥ 23 or overweight. For the remaining variables, participants were classified into either “Yes” or “No” group, based on their responses.

We applied logistic regression statistics to estimate the risk of poor sleep quality or work-related injuries. In developing the best-fitted model, we first estimated the individual effect of each variable on the outcome, poor sleep quality. Univariate logistic regression analysis was used for association between poor sleep quality and work-related injuries. Variables with a p-value of < 0.2 were considered as candidate variables. The final model contained only variables with p-value ≤ 0.05. All statistical tests were two-sided and analyses were performed using the licensed SPSS version 13.

Results
A total of 472 (99.4 percent) participants completed and returned the questionnaires. The majority of the participants were male (69.3 percent, n = 327). In total, 82 percent of the participants were married and 66.3 percent (n = 313) had less than college education. Among the participants, 21.2 percent (n = 100) were smokers and 61.9 percent (n = 292) consumed alcohol. Regular physical activities was reported by 69.3 percent (n = 327) of the participants and 41.9 percent (n = 198) had reported experiencing chronic pain. About one-third (35 percent, n = 175) of the study participants were classified as overweight. The majority (88.3 percent, n = 417) had more than five years of work experience, with 40 percent (n = 189) in rotating shift work schedule. Finally, 70.3 percent (n = 332) had reported satisfaction with their jobs (Table I).

Poor sleep quality was reported by 33.7 percent (n = 159). Participants whose Thai-PSQI scores had categorized into the good sleep quality category were predominantly men (39.6 percent, n = 187), age 45 or older (44.1 percent, n = 208), married (55.9 percent, n = 264) non-smokers (56.3 percent, n = 266) and had reported of no pain (42.2 percent, n = 199). The proportions of participants who had reported of consuming alcohol (33.7 percent, n = 159) and those who had reported otherwise (32.6 percent, n = 154) was almost equal. Participants who had reported more than five years of work experience (61.0 percent, n = 288) constituted the majority in the category of Good Sleep Quality. Finally, participants whose work schedule was classified as non-shift represented 46 percent (n = 217) of the good sleep quality group (Table II).

Results from the multivariable logistic regression analysis are presented in Table III. Male gender (OR = 2.74, 95 percent CI 1.46–5.17), alcohol consumption (OR = 2.1, 95% CI 1.24–3.35), pain (OR = 2.05, 95% CI 1.32–3.17), and rotating shift work (OR = 1.94, 95% CI 1.23–3.05) were associated with poor sleep quality.

Our statistical analysis yielded poor sleep quality was statistically significantly associated with work-related injuries (p < 0.001). Workers with poor sleep quality had about 3.98 times higher risk of work-related injuries than their counterparts with good sleep quality (OR = 3.98, 95% CI = 2.39–6.66).

Discussion
Findings from this study suggest that the prevalence of poor sleep quality is as high as 33.7 percent among Thai industrial workforce. Analyses of data yielded that male workers were
at more than two-fold risk for poor sleep quality. Our findings contradict previous studies which had reported females were more likely to experience poor quality sleep. The authors had attributed the poor quality of sleep among women to female reproductive hormonal changes[3, 25]. The difference between our study and previous ones might be explained by the differences in life style behaviors and age of participants. In our study the majority of the participants were 45 years of age and older. Additionally, the majority of participants in our study were non-smokers and were physically active and within the recommended range for their ideal body weights[26].

<table>
<thead>
<tr>
<th>Characteristics of the sample</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>327</td>
<td>69.3</td>
</tr>
<tr>
<td>Female</td>
<td>145</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 45</td>
<td>176</td>
<td>37.3</td>
</tr>
<tr>
<td>≥ 45</td>
<td>296</td>
<td>62.7</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>384</td>
<td>81.4</td>
</tr>
<tr>
<td>Single</td>
<td>88</td>
<td>18.6</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; College</td>
<td>313</td>
<td>66.3</td>
</tr>
<tr>
<td>4-year college or higher</td>
<td>159</td>
<td>33.7</td>
</tr>
<tr>
<td><strong>Smoking habit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smokers</td>
<td>100</td>
<td>21.2</td>
</tr>
<tr>
<td>Non-smokers</td>
<td>372</td>
<td>78.8</td>
</tr>
<tr>
<td><strong>Alcohol consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>292</td>
<td>61.9</td>
</tr>
<tr>
<td>No</td>
<td>180</td>
<td>38.1</td>
</tr>
<tr>
<td><strong>Exercise</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>327</td>
<td>69.3</td>
</tr>
<tr>
<td>No</td>
<td>145</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>Chronic pain</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>198</td>
<td>41.9</td>
</tr>
<tr>
<td>No</td>
<td>274</td>
<td>58.1</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (18.5–22.9 kg/m²)</td>
<td>297</td>
<td>62.9</td>
</tr>
<tr>
<td>Overweight (&gt; 23 kg/m²)</td>
<td>175</td>
<td>37.1</td>
</tr>
<tr>
<td><strong>Year of work experience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 5</td>
<td>55</td>
<td>11.7</td>
</tr>
<tr>
<td>&gt; 5</td>
<td>417</td>
<td>88.3</td>
</tr>
<tr>
<td><strong>Shift work</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>189</td>
<td>40.0</td>
</tr>
<tr>
<td>No</td>
<td>283</td>
<td>60.0</td>
</tr>
<tr>
<td><strong>Job satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>332</td>
<td>70.3</td>
</tr>
<tr>
<td>No</td>
<td>140</td>
<td>29.7</td>
</tr>
</tbody>
</table>

Notes: n = 472
Our findings that alcohol consumption increases the risk of poor sleep quality concur with previous reports[8]. In this study, we did not assess quantity of alcohol consumed per day; however, others have reported sleep quality is compromised with increased alcohol consumption[27]. Our results suggested an association between smoking and poor sleep quality, although this association did not reach the level of statistical significance. Previous studies suggest that smoking habit compromises sleep quality because of its adverse impact on the respiratory system[28, 29]. For example, Krishnan et al[30] argues that smoking...
induces collapse of the upper airway muscles; furthermore, they suggest that nicotine changes neural reflexes which increase in arousal threshold from sleep. Additionally, the authors propose that smoking induces inflammation of the upper airways.

Insufficient sleep duration and quality are commonly reported in patients suffering from a variety of acute or chronic pain conditions[31, 32]. In this study, industrial workers who had pain experienced from musculoskeletal disorders such as shoulder pain, low back pain or knee pain reported poorer sleep than those who had not. Pain perception was significantly associated with poor sleep quality. However, across most prior medical interventions, the development of pain as a side effect coincides with the development of sleep disturbance and vice versa[33]. Recent experimental studies suggested that sleep disturbances may impair key processes that contribute to the development and maintenance of chronic pain[34].

Workers who had working experience less than five years reported high poor sleep. It can be described by their age. As young adults, sleep quality may be involved with their social-techno life style and ability to cope with the stress[10].

Regarding shift work, industrial workers who had previous shift work experiences were more likely to have poor sleep quality than those who had never done shift work. Nevertheless, individual tolerance to shift work remains a multifaceted problem that is affected by the number of consecutive work hours and shifts, the rest periods and the predictability of work schedules[35]. In this study, workers in industrial setting work for 8-h shift. However, the schedule can be arranged as 16 consecutive work hours (day shift to evening shift) depending on workload and their work tasks. Most of workers had one-hour rest period between day and evening shift. We also found that only male workers had shift work. Therefore, it might be an explanation why male workers in this study reported poorer sleep quality than female workers.

Our findings also indicated that poor sleep quality was significantly associated with work-related injury, workers with poor sleep quality had a 3.98 times higher risk of being injured than workers with good sleep quality (OR = 3.98, 95 percent CI = 2.39–6.66). The result was consistent with a systematic review and meta-analysis of sleep problems and work injuries by Uehli et al[2]. In that study, it was found that workers with sleep problems had 1.62 times higher risk of being injured than workers without sleep problems (RR = 1.62, 95 percent CI: 1.43–1.84).

The strength of this study was the large samples size and high response rate. There are some limitations in this study. First, since this was a cross-sectional design, the findings from this study cannot determine causal relationships as might a prospective study. Second, the results were also based on the data from a convenience sample of large factories in Northern Thailand, thus the results may not be generalizable to all working population. Third, all of the survey data were based on self-report without clinical verification, which may bias the results. As a result, this study was not able to determine which aspects of the internet or social media use (e.g. Facebook, Line, Twitter and Youtube) which potentially related to poor sleep quality. Forth, other factors that possibly affect sleep quality, such as stress, anxiety, medication, drug use and sleep hygiene were not measured.

Conclusions and recommendation
Industrial workers with health risk behavior profiles, being male and shift work were risk for having poor sleep quality. Low sleep quality was associated with an increased risk of occupation injury. Health-related professional should pay attention to these factors which increase the workers’ vulnerability to poor sleep quality. Based on study results, developing of health education regarding good sleep hygiene, healthy behaviors and improvement of working conditions should be implemented for industrial workers.
References


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Women’s experiences and acceptability of medical termination of pregnancy
Results of an introductory study in Thailand

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Wanapa Naravage
Faculty of Public Health, Thammasat University, Pathumthani, Thailand

Abstract

Purpose – The purpose of this paper is to understand women’s experiences, acceptability and outcomes of using the medical termination of pregnancy (MTP). The study is conducted at nine reproductive health and family planning clinics at university hospitals as well as regional and provincial hospitals located in Bangkok and the locations within Thailand.

Design/methodology/approach – This is a descriptive research recruiting healthy women with pregnancy up to 63 days since the last menstrual period (LMP) who opted for MTP during 2012–2014.

Findings – A total of 443 women who were referred from the reproductive health networks voluntarily participated in the study. Overall, 92.6 percent of participants had a complete abortion. No serious adverse events were found for cases using misoprostol at home or at clinic. More than 98.3 percent of the women felt satisfied or very satisfied with the method. More than 80 percent of participants thought that the side-effects of the method were as expected or less than expected. More than 95 percent of the women recommended having MTP available in Thailand.

Originality/value – The introduction of MTP that uses a mifepristone and misoprostol regimen (Medabon®) in pregnancies up to 63 days, since LMP demonstrates that misoprostol can be safely used by women at home or at clinic. The administration of misoprostol at home reduces the number of hospital visits, which saves time and costs for traveling from home to the facility. In addition, women have more privacy and control over their bodies by self-administering misoprostol. The MTP’s introductory results also show that MTP service provision is well integrated into reproductive health and family planning services. It is useful for stakeholders who would be involved in design and planning of health system services before the MTP is made broadly available throughout the country.

Keywords Abortion pills, Medical abortion, Medical abortion introduction, Medical termination of pregnancy, Mifepristone, Misoprostol

Paper type Research paper

Introduction

In Thailand, the issue of termination of pregnancy (TP) is often controversial and emotional and has significant socio-cultural and religious implications. Thus, women who have faced this situation have often hidden the issue and sought various means to terminate an
unplanned or unwanted pregnancy[1]. One of the most commonly sought ways has been with medical abortion products. Illegal in Thailand, the products have become known and available throughout the country largely via the internet. They are now obtainable, albeit in diverse regimens and at significant cost to consumers. Due to the danger of self-medication resulting in complications, the rapid and widespread uptake of medical abortion products created an issue that required urgent attention.

The provision of safe TP within the full extent of the law is an important component of reproductive health services. Providing women with a choice in TP methods improves satisfaction, and some health care providers find it easier to provide medical termination of pregnancy (MTP) than to perform aspiration. The provision of MTP can also improve access to TP services as various types of health care professionals can be trained to provide MTP.

The most effective regimen for early TP consists of the use of 200 mg of mifepristone (Mf) followed 24–48 h later by 800 µg of misoprostol (Ms). Mifepristone is an antiprogestin that blocks the action of progesterone so the uterus cannot sustain a developing pregnancy. Mifepristone also makes the uterus more sensitive to prostaglandins and softens and dilates the uterine cervix. Prostaglandin analogues, such as misoprostol, cause uterine contractions which lead to the expulsion of uterine contents. As of 2017, mifepristone is licensed in 65 countries for the termination of early pregnancy[2]. In 2005, the World Health Organization (WHO) included mifepristone and misoprostol for early TP on its Model List of Essential Medicines[3]. The regimen used in this study is the same regimen as listed in the latest WHO clinical practice handbook for safe abortion in 2014[4].

Expected normal effects of MTP during and after administration include vaginal bleeding and cramping. Vaginal bleeding from MTP, often accompanied by the passage of clots, is usually heavier than during a menstrual period. Bleeding sometimes begins after taking mifepristone, but most often starts 1–3 h after misoprostol is taken. The amount and duration of bleeding vary: bleeding is generally heaviest for a few hours during the actual abortion and has the general pattern of diminishing over time, often lasting up to two to three weeks. Cramping is typically strongest in the hours after misoprostol is taken, and then eases off after the pregnancy has been expelled[5, 6]. During MTP, women may experience what feels either like an intense, crampy and long menstrual period, or like a spontaneous miscarriage. After the pregnancy passes – which the woman may not be able to differentiate from other blood and/or clots – she will likely experience a persistent decrease of bleeding and cramps until the bleeding ends. Uterine contractions can be painful, and some women will experience side-effects including nausea, vomiting, diarrhea, headache, chills, shivering and transient fever lasting less than a day[7]. There are no long-term health effects of MTP, nor will the medication impact any future pregnancies[8].

Even though MTP has been used in several countries around the world for more than a decade, this method was first officially introduced in Thailand at five medical schools and four state hospitals. Before making MTP available in the Thai health service systems nationwide, it is important to assess the experiences of women using MTP. Therefore, the purpose of this study is to assess the acceptability, the outcomes of using MTP, and examining side-effects and service delivery. The study recruited women at gestations not later than 63 days since the last menstrual period (LMP).

Material and methods

Design of the study
This was a descriptive, observational study to understand women’s experiences, outcomes from using MTP, the acceptability of side-effects and service delivery with the combination regimen of mifepristone and misoprostol (Medabon®) for TP up to 63 days since LMP.

Data collection tools included clinical data and women’s acceptability record forms at admission, on day 2 or day 3, and at the follow-up visit on days 10–14.
Setting
The study was undertaken at reproductive health and family planning clinics in five medical schools and four state hospitals located in Bangkok and at provincial locations in Thailand. All of these selected sites were providing a surgical method for TP within the context of the Thai law and Medical Council’s regulations.

Study volunteers
A quota sample of a total of 450 women (50 volunteers/clinic) was recruited from women requesting legal TP through the reproductive health referral network. Participants who were enrolled in the project were within the inclusion criteria, the abortion law and the Medical Council’s regulation. A total of 443 healthy women voluntarily participated in the study.

Inclusion criteria and exclusion criteria
See Table I.

Description of the intervention process
The intervention consisted of the following components:

- selection of health facilities to perform MTP;
- adaptation of international MTP training curricula to the needs of the Thai health service system;
- adaptation of values clarification and materials to counsel about options, to the needs of the Thai health service system;
- training of health care providers at the selected study sites in the provision of MTP services including values clarification and counseling about options;
- development of a service protocol for MTP using international guidelines;
- development and testing of information, education and communication materials for providers and women;
- development of a recordkeeping system to be used for the study and to provide insights for recordkeeping in routine service delivery;

<table>
<thead>
<tr>
<th>Inclusion criteria: women were recruited if</th>
<th>Exclusion criteria: women were not recruited if</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requesting abortion</td>
<td>Allergic to mifepristone or misoprostol</td>
</tr>
<tr>
<td>Willing and able to participate after</td>
<td>They had history or evidence of disorders that represented a contraindication to the use of mifepristone (chronic adrenal failure, severe asthma uncontrolled by corticosteroid therapy, inherited porphyria) or of prostaglandins</td>
</tr>
<tr>
<td>information about the study was provided</td>
<td>They had history or evidence of thromboembolism</td>
</tr>
<tr>
<td>Eligible for legal termination of pregnancy[9, 10]</td>
<td>They experienced severe or recurrent liver disease</td>
</tr>
<tr>
<td>In good general health;</td>
<td>Had a medical condition or disease that required regular treatment with systemic drugs, care or precaution (e.g. corticosteroid or anticoagulant therapy) in conjunction with abortion</td>
</tr>
<tr>
<td>Their pregnancy was not more than 63 days, verified by physical examination (PE), per vaginal examination (PV) and/or ultrasound</td>
<td>Had uterine fibroids that were likely to affect bleeding or contractility</td>
</tr>
<tr>
<td>Their pregnancy was single and intrauterine (single sac)</td>
<td>There was the presence of intrauterine device in utero</td>
</tr>
<tr>
<td>And agreeing to have the abortion with a surgical method, if treatment with a combination of Mf and Ms failed</td>
<td>Or were breastfeeding</td>
</tr>
</tbody>
</table>

Table I. Inclusion and exclusion criteria for selecting study participants
collection of data on service provision and outcomes of the treatment including adverse events;
provision of MTP using practical guidelines;
interviewing providers and women who have used MTP and collecting their opinions of MTP service;
assessment of how the provision of MTP affects services and costs;
reporting of the outcome of MTP including rates of complete and incomplete termination of pregnancies and failures and complications, if any;
review of the experience of MTP provision in a participatory process with stakeholders for the development of a strategy for the wider availability and accessibility of MTP in Thailand;
analysis of the experience of MTP service in a participatory process with stakeholders for the development of a strategy for the wider availability and accessibility of MTP in Thailand;
organization of a dissemination workshop; and
preparation of scientific papers on the results.

The regimen for MTP to be used
The regimen for MTP used in the study consisted of one 200 mg tablet of mifepristone followed 24–48 hours later by four tablets of 200 μg misoprostol each. This protocol was based on the recommended MTP regimen by WHO and the UK Royal College of Obstetricians and Gynecologists[4, 11]. This regimen was approved in Thailand by Thai FDA in December 2014[12] (Table II).

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Procedure and data collection process</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission, day 1</td>
<td>Vaginal examination (PV) and/or ultrasound exam (if judged necessary) to verify the length of pregnancy and check that pregnancy is intrauterine</td>
<td>Mf 200 mg orally (1 tablet)</td>
</tr>
<tr>
<td>Day 1 at clinic</td>
<td>Medical and gynecological exam, height, weight and blood pressure (BP) according to hospital’s practice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical examination</td>
<td></td>
</tr>
<tr>
<td>Day 2 or 3 (24–48 h) at clinic or at home</td>
<td>At clinic</td>
<td>Ms 0.8 mg vaginally or sublingually</td>
</tr>
<tr>
<td></td>
<td>Brief interview</td>
<td>(4 tablets of 0.2 mg)</td>
</tr>
<tr>
<td></td>
<td>Measurement of BP and pulse rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hourly record of temperature, noting possible side-effects and noting any medication given during the 3-h clinical observation period</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recording exact time of expulsion</td>
<td></td>
</tr>
<tr>
<td>End of study</td>
<td>At home</td>
<td>If the subject is still bleeding at this visit, she must be examined and a follow-up appointment made</td>
</tr>
<tr>
<td>Day 10–14 follow-up visit at clinic</td>
<td>Medical and perception interview and review of diary card recorded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pelvic examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultrasound examination if judged necessary from clinical findings</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Mf, mifepristone; Ms, misoprostol; BP, blood pressure

Table II.
Treatment plan and study process
Statistical analysis
The data were analyzed centrally at the Concept Foundation in Pathumthani, Thailand. The statistical analysis was done using SPSS 17.0 software for Windows. Descriptive statistics were calculated for all baseline characteristics for all study subjects, to describe characteristics of the population, efficacy, side-effect by routes and place of administration. The main efficacy analysis included all subjects from nine hospitals for whom the treatment outcome was known. The safety and acceptability analyses were assessed during the follow-up visit and included all women.

Ethics and independent ethics committee
The study was approved by the ethical committee of the institutional at all participating hospitals before each center starts recruitment of the study participants. Only Health Promotion Hospital, region 6 Khon Kaen, implemented the study based on the Department of Health’s policy on safe abortion in 2012. Following are the listed certificate ethical committee approvals:

- Chulalongkorn medical school, Chulalongkorn University, IRB No. 227/54, dated June 7, 2011.
- Siriraj Medical medical school, Mahidol University, EC No. Si 061/2012.
- Ramathibodi medical school, Mahidol University, EC No. MURA2011/252 dated July 4, 2011.
- Srinakarin hospital, Khon Kaen University, IRB No. 00001189, dated August 7, 2013.
- Sonklanakarin hospital, Prince of Songkla University, EC: 56-223-12-1-1, dated May 20, 2013.
- Health Promotion Center (HPC), region 6 Khon Kaen, implemented under the Department of Health’s policy in 2012.
- Nan provincial hospital, EC No., Nor Nor 0032.2/1679, dated May 23, 2013.

The women who chose medical abortion were informed about the study and invited to join. All potential volunteers were informed about the aims and procedures of the study, side-effects that may occur as a result of the treatment and the alternative methods of pregnancy termination that was (were) available. They were also informed about the measures taken to ensure confidentiality and their right to withdraw from the study at any time without prejudice to their further medical care. Women who decided to participate in the study were asked to sign the consent form before enrollment into the study; the consent form was written in the subject’s own native language. For women who were under 18 years, investigators requested parent(s) and women to provide consent after they received information about the study.

Results
Recruitment started in March 2012 and finished in November 2014. A total of 446 women were recruited. Three women were excluded from the analysis due to their gestational age of more than nine weeks. In total, 443 healthy pregnant women with 63 days or less of gestation were enrolled in the study. Eight women were lost to follow-up and excluded from the analysis. Therefore, 435 women were included for efficacy, safety and acceptability analysis. Protocol violation happened in the cases of two women who received only mifepristone.

Details of the brief outcome of participants are shown in Figure 1.
Baseline characteristics were similar among the nine study centers. The mean age was about 26.5 years old (SD ± 7.6), between 13 years and 45 years. A total of 221 women (or 50.2 percent of all women recruited) had been pregnant before. The mean gestational age was 46.5 days (SD ± 8.6) with minimum 28 days and maximum 63 days. In total, 70.2 percent of the women had gestational age (GA) at ≤ 49 days and 4.7 percent with GA 57–63 days (Table III).

Misoprostol at home or at clinic
After the women took a tablet of mifepristone at the clinic, they needed to administer misoprostol 0.8 mg vaginally or sublingually at home or in the clinic on day 2 or day 3 (24–48 h) to complete the course of MTP. The results revealed that 65.3 percent of women preferred to use misoprostol at home. The rest (or 34.7 percent) administered misoprostol at the clinic. This was true both in Bangkok and up-country (Table IV).

End results after complete MTP (Medabon®)
In total, 383 women of the 435 completed abortion with the original one pack of Medabon®. Therefore, the success rate of using the original regimen (one pack of Medabon®) was 88.1 percent, including both routes of administration of Ms. If 20 women who received additional...
misoprostol at the first follow-up visit were included, the success rate of complete abortion was 92.6 percent. A total of 29 women completed abortion using surgical methods after using MA (Table V). Since the MTP process may feel similar to spontaneous miscarriage, some of the women became worried and requested to interrupt the MTP process and use a surgical method.

Experiences of side-effects and complications
In general, there were no severe complications reported in this study. Nausea related to pregnancy and/or related to the use of misoprostol sublingually was reported at 58.8 percent. Of drug-related side-effects, diarrhea was also commonly found at 71 percent.

There was one case report of a maculopapular rash appearing on a participant’s chest, abdomen and both hands about 2–3 h after the administration of mifepristone. The woman felt itching for 1–2 days and visited a hospital where she was treated with an oral antihistamine and she recovered fully.

The degree of abdominal pain was classified on a scale from 0 to 10. The mean degree of pain reported was 2.9 (SD ± 2.97). There were two cases reported at a perceived “10” degree of abdominal pain.

Table VI reveals the women’s subjective assessment of MTP experience at the follow-up visit on days 10–14 as well as their perception of privacy of services. Overall, 76 percent (328/433) of the women had experienced less pain or the same pain as expected. 65.4 percent (281/430) of the women reported either less bleeding than expected or the same as expected.
In total, 80.6 percent (349/433) of the women reported that the duration of bleeding was shorter than or as expected, whereas 51.4 percent of the women expressed that the duration of bleeding was long but acceptable (Table VII). A total of 61.5 percent (260/423) revealed that other side-effects were less than expected (Table VI).

Acceptability
As per Table VII, 49.9 percent (214/429) of the women revealed that “none” of the features of the method could be considered the worst. When asked what the worst feature of the MTP procedure was, women responded that the following effects from using MTP were considered the worst: pain, nausea/vomiting and bleeding at 19.1, 13.1 and 7.5 percent, respectively.

When asked whether they were satisfied with the medical abortion method, 98.3 percent (425/432) reported being satisfied or highly satisfied (Table VIII).

Discussions
The MTP regimen used in the early TP (less than or equal to 63 days) consisted of 200 mg mifepristone orally followed 24–48 hours later by 800 µg misoprostol vaginally or sublingually. Then, the women need to come for follow-up on days 10–14[13, 14]. Protocol violation happened in the cases of two women who received only mifepristone. Of the two women who only received Mf and not Ms, one woman who completed abortion was confirmed on the follow-up visit. The other woman had a continuing pregnancy confirmed by ultrasound. This case had a twin pregnancy. When the first fertilized embryo expelled, the provider thought that the woman had had a completed abortion, so the provider decided by herself to ignore the remaining tablets of Ms. These results suggest that whether abortion is completed or not, providers need to administer the full course of Mf and Ms based on the study protocol.

The characteristics of the study participants in Table III showed that nearly 80 percent of the women terminated their pregnancy at the ages of 18–39 years. This result suggests that

<table>
<thead>
<tr>
<th>Feature of the method considered the worst</th>
<th>None</th>
<th>Pain</th>
<th>Bleeding</th>
<th>N/Va</th>
<th>Too long</th>
<th>Discomfortb</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
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<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>214</td>
<td>49.9</td>
<td>82</td>
<td>19.1</td>
<td>32</td>
<td>7.5</td>
<td>56</td>
<td>13.1</td>
</tr>
</tbody>
</table>

Table VII.
Number and percentage of features of the MTP and bleeding perception of women from nine study clinics

<table>
<thead>
<tr>
<th>Duration of bleeding</th>
<th>Too long</th>
<th>Long but acceptable</th>
<th>As expected</th>
<th>Less than</th>
<th>Very little</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>24</td>
<td>5.6</td>
<td>222</td>
<td>51.4</td>
<td>109</td>
<td>25.2</td>
<td>72</td>
</tr>
</tbody>
</table>

Notes: aNausea/vomiting; bVaginal examination discomfort

<table>
<thead>
<tr>
<th>Table VIII.</th>
<th>Number and percentage of acceptability of women with MTP from nine study clinics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly satisfied</td>
<td>Satisfied</td>
</tr>
<tr>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>284</td>
<td>65.7</td>
</tr>
</tbody>
</table>
unwanted/unplanned pregnancy can occur to women at any time during their reproductive age, and not only among teenagers who have less experience with birth control.

The reproductive health referral networks are an important mechanism to help women get easy access to safe abortion services, since there are few facilities officially providing the services. In this study, the majority of the study participants were referred by the reproductive health network, suggesting that this channel could reduce the time needed for women to seek safe abortion services. This, in turn, resulted in 70 percent of women terminating their pregnancies at a low gestational age – less than 49 days since LMP (Table III).

It is important to note that in the Thai context, abortion is often controversial, emotional and has significant socio-cultural and religious implications. Therefore, by using MTP at home, women felt more comfortable to manage the final stage of fertilized fetal expulsion in a private place. However, counseling and information is given on how to use Ms at home, plus expected side-effects and abnormal signs and symptoms which are critical. These key messages are important in assisting women to better manage the MTP process. Providers need to emphasize these key messages to all women before discharging them after taking mifepristone.

The success rate of complete abortion of the present study was slightly lower than the previous study by WHO in 2010, which was revealed at 94.2 percent[7]. One of the reasons for the lower success rate in this study was that some of the women interrupted the MTP process by asking for surgical intervention. Since the MTP process is similar to spontaneous abortion and the abortion takes a few days to complete, some women felt nervous when they faced several days of bleeding after completing the MTP regimen. Additionally, some providers who were used to terminating pregnancies by manual vacuum aspiration (MVA) felt that the MTP process took longer time compared to MVA. So they could not wait until completing abortion and interrupted the MTP process with MVA. Therefore, these cases were recorded as failed MTP because we were unable to conclude whether the woman had a complete or incomplete abortion. However, the success rate of MTP depends on providers. It is like a learning curve: the more they provide MTP, the more they learn[15].

There were no serious complications reported by the women who used misoprostol at home or at the clinic. There were only three cases that had unexpected, non-serious adverse events needing a few days of treatment and ending with full recovery. Thus, the introduction of MTP for pregnancies less than 63 days since LMP can offer benefits for reproductive health service systems, since the provision of MTP requires no hospital admission as women can use misoprostol at home safely.

In the present study, the follow-up evaluation was scheduled on days 10–14 after taking mifepristone which is appropriate to assess the experiences of women using MTP and to monitor vaginal bleeding. This was based on the fact that heavy bleeding may be delayed for a few days up to a few weeks after taking misoprostol and that some women may experience prolonged bleeding[5]. For follow-up visits, we assessed satisfaction with MTP in terms of the women’s experiences. The experiences of women included lower abdominal pain, bleeding, long duration of MTP process and side-effects associated with MTP. We found that the majority of the women’s experiences were not that severe than what they had expected. This may have been due to the fact that the women were provided with adequate counseling during the process.

Overall, the majority of the women (98 percent of women in both rural and urban areas) were satisfied or highly satisfied with the regimen for TP, which is consistent with findings from other countries[7, 15]. In addition, 95.8 percent of the women thought that MTP should be available in Thailand.

Understanding the experiences of women who opted for abortion using MTP (Medabon®) is useful for everyone who would potentially be involved in the preparation of the health systems for MTP provision. For sustainability and to reduce stigmatization, the provision of MTP should be integrated into the reproductive health and family planning clinics of each health care facility.
As this study involved the introduction of MTP in nine hospitals, we believe that it will be important to conduct a bigger survey after MTP is listed in the National List of Essential Medicines in order to compare service provision of MTP at various levels of health care facilities and assess women’s satisfaction as well as accessibility.

Conclusions

The regimen of MTP, or the combination package of mifepristone and misoprostol for TP less than 64 days since LMP[13, 14] consisting of 200 mg mifepristone orally followed 24–48 h later by 800 µg misoprostol vaginally or sublingually, has been demonstrated as effective and easy to use. Counseling and information given to women in order to use misoprostol at home by themselves is highly acceptable among women both in Bangkok and other provinces. No serious adverse events were recorded. Overall, most of the women in both rural and urban areas were either satisfied or highly satisfied with the regimen for TP. Reproductive health referral networks are an important channel to assist women to access the safe abortion services as soon as possible. To reduce stigmatization, MTP should be integrated into the Reproductive Health and Family Planning Clinic of each health facility.

Acknowledgment

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Conditions of caring for the elderly and family caregiver stress in Chiang Mai, Thailand

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Abstract

Purpose – The family caregivers play an important role in the good quality of life for the elderly, but most of them can easily have an emotional and psychological effect on caregiving. The purpose of this paper is to explore the correlation between conditions of caring for the elderly in the family and caregiver stress in a community setting, Chiang Mai Province, Thailand.

Design/methodology/approach – A cross-sectional exploratory descriptive research was conducted in Ban Klang Subdistrict, San Pa Tong District, Chiang Mai Province. Simple random sampling was used to collect data by using a structured interview via a questionnaire with 103 elderly caregivers. The \( \chi^2 \) test was used to explain the conditions related to stress as being a caregiver.

Findings – Most of the caregivers were female and still in good health, but at the same time, underwent little stress. However, they did not receive any training beforehand for taking care of the elderly but mainly done by experience, relationship and gratitude. The conditions correlated with stress as being a caregiver were health status of caregivers, confidence of care, the relationship between caregiver and elderly person, and economic burden of care.

Originality/value – A necessary resource such as body of knowledge in elderly caregiving, long-term care system at the community level and social support from family and intimate persons will encourage confidence in taking care of the elderly in the family and also relieve caregivers’ stress.

Keywords Elderly, Family caregiver, Chiang Mai

Paper type Research paper
Introduction

In 2015, Thailand was considered to be an aged society, ranking second after Singapore among the ASEAN member countries due to the dramatic change of population structure in Thailand during 3–4 decades, and six years from 2015, Thailand will be a complete aged society[1, 2]. Caregiving for the elderly nowadays not only focuses on medical care but also needs to cover emotional support and stimulates active ageing for the elderly[3]. Caregiving for the elderly in Thailand needs to be operated and delivered by family and community because living with their family in the primary community and familiar surroundings as well as receiving support from their family would produce better results for the elderly[2, 4, 5]. Since Thai society upholds values of gratefulness, and considers care and assistance provided for the elderly in their daily lives to be the duty of their children in the family[6] by having their descendants, spouse and relatives take primary responsibility in caring for the elderly[7], so increasing capacity in various aspects for family members caring for the elderly is needed, especially the importance should be placed on the elderly caregivers[8].

The caregivers have a duty to help and support the elderly to enjoy their daily lives, but on the other hand, most of them are likely to be physically and mentally affected, causing the more negative outcome to their quality of life than to other family members[9, 10]. Because these caregivers can easily have emotional and psychological stress, the feelings of worry, confusion and boredom with caregiving as well as the lack of accurate knowledge of guidelines to caring for the elderly[11] may cause them to lack confidence and worry about caregiving, especially those who have to care for the elderly with depression, dementia and Alzheimer symptoms which require continuous and palliative care.

However, most of the caregivers are unpaid[12], and in Thai society, they have no bargaining power. Generally, they deliver care under the condition of gratefulness, but may have never prepared themselves for caregiving or have never had experience or knowledge of caring for the elderly[13]. If the caregivers solely assume the burden of caregiving and any kind of impact, this will eventually lead to an end of caregiving for the elderly in the family and have to make a referral to external agencies to carry out the caregiving[14]. Thus, the elderly will have less chance to live the rest of their lives with their family. Depression in family caregivers comes not only at a great personal cost to their families but also at a substantial financial cost to the society[15].

The elderly’s caregivers in the family therefore play an important role in the elderly’s good quality of life. While the elderly have been taken good care of, the elderly caregivers should also be recognized for their value and importance. This study aims to examine the correlation between conditions of caring for the elderly and stress of the family caregivers for the sake of fostering collaboration among family members, community and agencies involved to support these family members as caregivers to care for the elderly in the family happily by means of giving any support needed for long-term caregiving for the elderly.

Caregiver stress and burden of care

Mainly, the term caregiver refers to anyone who provides assistance to someone else, who is, to some degree, incapacitated and needs help. Therefore, caregivers are often responsible for providing physical and emotional support to elderly family members who can limit their ability to participate in regular social activities and decrease their well-being[16]. In addition, the caregiving experiences often lead to multidimensional stressors like physical, psychological, emotional, social and financial depending on the status of the demented recipient[17]. The role of caregiver is associated with negative outcomes for the family caregiver such as health and overall well-being. Moreover, both a longer duration of caregiving and coresidence put the caregiver at risk for more negative outcomes. Then, the accumulation of stress over the course of caregiving may occur[18]. Thus, caregiver stress is the unequal exchange of assistance among people who stand in close relationship to one another, which results in emotional and
physical stress on the caregiver. In addition, caregiver stress has also been used to describe the objective and subjective burdens that caregivers face[19].

The degree of burden experienced by caregivers depends on several contextual factors, caregiving-related factors and primary stressors including the socio-demographic status of caregivers and care-recipients, disease progression suffered by the care-recipient and the perceived stress from caregiving. For example, caregivers who advanced in age, women and co-residents experience greater burden than young, male caregivers and those who live apart from care-recipient, and spousal caregivers experience the highest level of burden. Moreover, the functional status of care-recipient, and they independently also affect caregiver burden[20]. Many studies found that most of the caregivers are middle-aged women, being either a daughter or a wife, and likely that their emotional state has changed or been followed by depression[21, 22]. Because women are more vulnerable to burden experience than others, they need specialized support and counseling that address these unique sources of burden[16]. Moreover, informal care for the disabled elderly has proved to be a heavy burden for family caregivers in many countries, and the burden has been shown to be related to the socio-demographic characteristics of both the caregiver and the recipient of care[23]. As same as the elderly with dementia condition, the symptoms might be more severe and become a long-term burden for the caregivers to deliver care to this group of the elderly[24, 25] in the same way as to the elderly with chronic health condition[13, 26]. This may later cause the caregivers’ health problem(s)[14]. It could be observed from the higher ratio of this group of caregivers going to consult a specialist about psychological problems than other groups[27], especially those who are getting to suffer from insomnia, feel fatigue from caregiving or have a feeling of a great burden of care are likely to have more stress[28]. Due to health status deterioration and fading memories of the elderly, providing care for this group of recipients is emotionally draining and difficult[15]. Thus, the caregivers may undergo more stress and feel uncomfortable during caregiving than taking care of the general elderly person. In addition, these caregivers have to spare some of their private time and social life to take a close care of the elderly.

Caregiver burden is identified as a state resulting from providing the necessary care to an impaired older adult but that threatens either the physical or psychological well-being of the caregiver[23]. At the same time, it has been defined as the type of stress or strain that caregivers experience related to the problem and challenges they face as a result of the status of care recipient[17]. However, the term caregiver burden has similarities to caregiver stress. Many authors use these two terms interchangeably. The literature seems to present both terms as synonyms of each other[19]. The caregivers with an underlying disease may have more severe symptoms and other health problems after that. Some may even take a more complex role – taking more responsibilities and roles of, for example, parenthood having a burden to take care of their children or their spouse’s parents[8]. A burden of caring for the elderly may make the caregivers have less time for recreational activities which also affects the caregivers’ mental health[29]. Empirical referents associated with caregiver stress include depression, anxiety, irascibility, disturbances in cognition, decline in physical health and yielding of caring role[19].

In many non-nursing studies related to the stress of the AD caregiver, the concept of caregiver stress is mostly measured utilizing the Zarit burden scale, while Pearlin et al.’s stress process model (SPM) was also used in non-nursing and nursing articles measuring caregiver stress. A caregiver’s role could be in what seems to be stressful. However, if he/she does not perceive his/her situation as stressful, then it is not stressful. Caregiver stress is therefore measured by subjective burden scales because it is perceived by the caregiver[16]. The Zarit Burden Interview (ZBI) was designed to evaluate the challenges that family caregivers of elderly and persons with disabilities face on a daily basis. It contains diverse item content, and takes into consideration both objective and subjective
burdens experienced by the caregiver[19]. Therefore, in this study, the term caregiver stress will be used similarly with caregiver burden and focused to explain family caregiver stress by using the caregiving SPM, developed by Pearlin et al.[30], as a theoretical framework. Caregiver stress was viewed as a consequence of a process comprising a number of interrelated conditions, including the socioeconomic characteristics and resources of caregivers and primary and secondary stressors to which they are exposed. The onset and progression of chronic illness and functional decline are stressful for both recipient and caregiver and linked to being exposed to a severe, long-term, chronic stressor. The stress process is made up of four domains: the background and context of stress; the stressors; the mediators of stress; and the outcomes or manifestations of stress[15, 30]. The details were as follows.

First, the background and contexts of the stress process refer to socioeconomic status characteristics (such as age, educational level, sex and ethnicity), caregiving history (the relationship of the caregiver to care recipient, quality of the relationship, extent of health problem and duration of caregiving), family and network composition (attachments, structure of the networks and contacts that the caregiver has as a means of support), and program availability (access to community resources that decrease isolation). Second, the stressors common to the caregiving experience are divided into two categories: primary and secondary stressors. Primary stressors are the demands and needs of the care recipients, for example, the impacts of symptoms such as memory loss, communication deficits and recognition failure that accompany the encephalopathy. Secondary stressors are related to the role and intrapsychic strain, which encompass the effects that caregiving has on one’s psychological state and on one’s ability to work and participate in outside activities. Third, mediating conditions are the mediators which caregivers use to buffer, manage or prevent stress. Coping and social support are considered mediators that determine how caregivers respond to stress and there are two categories of social support, i.e., instrumental and expressive. Finally, outcomes are the last component that involves the consequences and impact of the stress related to the caregiving experience[31].

However, this study did not focus to examine the interrelation between all components, but only used this model to determine the conditions of caring for the elderly which are related to the stress of caregivers. Economic status of caregiver refers to background and contexts of the stress process. Dementia caregiving and economic burden with caring played the role of primary stressors, while confidence of caring and perceived health status of caregiver were secondary stressors, and the relationship between caregiver and care recipient was defined as the mediator of stress. On the other hand, all of these variables were group into conditions of caring for the elderly which related to stress of caregiver in this study and divided into two parts of condition, namely, Readiness of the caregiver which included: health condition, confidence of caring, and economic condition of caregiver; Dependency of the elderly which included: dementia caregiving, relationship between caregiver and care recipient, and economic burden of caring.

Materials and methods

Study design
This cross-sectional exploratory descriptive research was a part of “Comparison survey on family caregivers of elderly people in Thailand and Japan,” which aims to investigate the current situation of family caregivers and to conduct an international comparison survey of family caregivers in Japan and Thailand in order to improve the quality assurance of in-home elderly care, and obtain basic data that can be used for constructing family support systems in both countries through collaboration and applying each country’s strengths[32].
Participants

Participants were the in-home family caregivers for the elderly in the community setting of Chiang Mai Province, Thailand. The sample size was calculated from at least 100 samples by means of calculation of sample size using a formula of \( n = 10K + 50 \) (\( K = \) a number of key variables studied equals to 5 variables)[33]. Simple random sampling was used to collect data from the elderly caregivers in total 103 households where the elderly had been living in. The participants’ inclusion criteria consisted of being primary caregivers who were responsible for taking care of the elderly people at home. If in each household, there were more than one elderly person, an elderly recipient who needed the most severe care in the family, for example elderly person with dementia or oldest person, was selected to give their information in the study. However, there were no more than one recipient in each household in this study because, in general, if there are a couple of elderly persons who were spouse, one would take the role of caregiver while another as a recipient, or the oldest elderly would be a recipient while the younger was a caregiver.

Study area

The community area in Chiang Mai Province was chosen to be the study area as it has been the most populated province in the north; 16.8 percent of the entire population was the elderly. The population of the elderly in 2016 was 5.1 percent higher than that in 2015[34], and aging index was considered high at 90.5 in 2013 and expected to increase to 160.27 in 2020[1]. The area of Ban Klang Subdistrict, San Pa Tong District was chosen to be the study area by using purposive sampling.

Data collection and instruments

Data collection was carried out from April to November 2016 by a structured interview via a questionnaire, and took place in the caregiver’s home. The questionnaire was developed by key researchers from Graduate School of Health Sciences, Kobe University. It was translated into Thai and adjusted to suit Thai community contexts and examined for content validity by three experts who were community health nurse, a nurse gerontologist, and public health personnel. The questionnaire covered characteristics of participants (family caregivers and care recipients); care burden; support in caring; emotional effect and training in caring of the elderly; opinion in taking care of the elderly; and motivation to continue caregiving of care receivers.

Family caregiver stress was measured by using the eight-item short version of the ZBI, which is proposed with the following two factors: Personal strain (five item) and Role strain (three items)[35]. Response to each item was rated on a 0–4 scale: 0 = “never,” 1 = “rarely,” 2 = “sometimes,” 3 = “quite frequently,” and 4 = “nearly always.” Higher scores reflect more severe care burdens or high stress. The scores were calculated by summing all items and ranged from 0 to 32. The scores of 0 indicate “no burden or stress”, 1–10 “mild or little stress,” 11–20 “moderate stress” and 21–32 indicating “severe burden or high stress.” A pilot study was conducted with 30 family caregivers with similar characteristics of the sample and the Cronbach’s alpha coefficient of the eight-item ZBI was 0.86.

Data analysis

Data were analyzed via descriptive statistics and the \( \chi^2 \) test. Descriptive statistics including frequency, percentage, mean and standard deviation were used to analyze basic information related to the status of the elderly caregivers in the family. Bivariate analysis using the \( \chi^2 \) test was used to explore the correlation between conditions of caring and stress among family caregiver.
Ethical consideration
Ethical approval for the research instrument had been obtained from Institutional Review Board of the Graduate School of Health Sciences, Kobe University, Japan (Reference Number: 452-1), which was approved on March 17, 2016. The Faculty of Nursing, Chiang Mai University recognized this consideration. All participants were given information about the research project and could terminate the participation when they feel unsatisfied with the situation. All the results were shown, only the outcomes of the study and the name or private information of participants were kept confidential.

Results
The findings were divided into the following four parts: characteristics of the elderly caregivers and the elderly; situations of caring for the elderly; conditions of caring for the elderly and level of stress; and the relationship between conditions of caring and perceived stress as being the elderly caregivers.

Characteristics of the elderly caregiver and the elderly
Out of 103 caregivers, two-thirds of them were mostly women (73.8 percent) at the average age of 49. Nearly, one-fourth of them were the elderly (20.3 percent), and half of them got married (55.3 percent). Considering the economic status of the elderly caregivers in the community, almost 79.6 percent were still working and had their own earned income (Table I).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
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<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>27</td>
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</tr>
<tr>
<td>Female</td>
<td>76</td>
<td>73.8</td>
</tr>
<tr>
<td>Age (years)</td>
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<tr>
<td>&lt; 30</td>
<td>9</td>
<td>8.8</td>
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<td>60–69</td>
<td>16</td>
<td>15.5</td>
</tr>
<tr>
<td>≥ 70</td>
<td>5</td>
<td>4.8</td>
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<td>Marital status</td>
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<tr>
<td>Married</td>
<td>57</td>
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<tr>
<td>Single</td>
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<td>36.9</td>
</tr>
<tr>
<td>Divorced/separated</td>
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<td>7.8</td>
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<tr>
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<td>82</td>
<td>79.6</td>
</tr>
<tr>
<td>Do not work</td>
<td>21</td>
<td>20.4</td>
</tr>
</tbody>
</table>

Notes: n = 103. Mean = 49.1; SD = 13.3

Table I. Characteristics of family caregiver

Situation of family caregiver in caring for the elderly
It was noticeable that a large number of the caregivers (56.3 percent) in this study stated that they did not prepare themselves beforehand for taking care of the elderly. Most of them
stated that they had never received any training on caregiving for the elderly, and almost half of them (45.6 percent) had never searched for any information regarding caregiving for the elderly before. One-third of the caregivers stated that they had no consultant in caregiving for the elderly. However, family members had been a core supporter of caregiving for the elderly and other assistance in the form of emotional support from friends, acquaintances, and religious organization(s). Most of them had financial support or assistance from public agencies or organizations, especially from subsistence allowance, and some from their kin, whereas some caregivers (17.5 percent) stated that they did not receive any financial support from any resource (Table III).

### Conditions of caring for the elderly and stress of family caregiver

The conditions of caring for the elderly in this study were divided into two factors: Readiness of the caregiver in terms of health status, confidence of care and the economic status of the caregivers; and Dependency of caring such as dementia caregiving, the relationship between the caregiver and the elderly, and the economic burden of care. The details are shown in Table IV.

#### Readiness of the caregiver

Considering the caregivers’ perceived well-being, approximately 53.3 percent evaluated themselves that their health condition, in general, was rather good. Moreover, half of the caregivers (53.3 percent) stated that they were extremely confident in assuming a burden of caring for the elderly. Though the rest of them had no work, only some of them (8.7 percent) felt they had run into economic difficulty.

#### Dependency of the elderly

Half of the elderly in the family (49.5 percent) suffered from dementia or faded memory. However, the relationship between the caregivers and the elderly was very good (73.8) and quite good (15.5 percent). Regarding the economic burden from taking care of the elderly, one-third of the caregivers (34.9 percent) stated that it was a heavy burden for them, while the others thought that it was quite some burden in a similar proportion (34 percent). On the other hand, some of the caregivers (31.1 percent) thought that caring for the elderly was not their economic burden.
Perceived stress of family caregiver. As a whole, the caregivers had positive attitude toward caregiving for the elderly in the family, but at the same time, underwent stress as taking a role of a caregiver which was something they could not avoid. The caregivers reported a varied degree of stress with a mean of 6.6. The majority of them (74.8 percent) experienced none or little stress, while some of them (21.4 percent) felt moderate stress in caring of the elderly and only 3.9 percent perceived high stress.

The relationship between conditions of caring and stress of the caregivers
Considering the conditions probably assumed to correlate with the caregivers’ stress using the $\chi^2$ test, it was found that the conditions related to the perceived stress of caregivers were health status, confidence of caring, the relationship between the caregiver and the elderly, and the economic burden of care. The details are shown in Table V.

Readiness of the caregiver. It was likely that a group of caregivers with good health condition was likely to have less stress than other groups ($p = 0.003$). Moreover, the caregivers with high confidence in caring for the elderly were likely to have less stress than those with less confidence ($p = 0.000$). However, the economic status of caregivers did not have a significant relationship with the stress of caregivers.

Dependency of the elderly in the family. It was obviously seen that if there was a good relationship between the caregivers and the elderly, the caregivers were likely to have less perceived stress ($p = 0.000$). In addition, if the caregivers did not feel that caring for the elderly was such a substantial economic burden for them, they were likely to have less stress ($p = 0.000$). However, the elderly with dementia did not find to have a significant relationship with caregiver stress in this study.

### Table III. Situation of family caregiver in caring for the elderly

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>$n$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for elderly caring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never prepare</td>
<td>58</td>
<td>56.3</td>
</tr>
<tr>
<td>A little</td>
<td>23</td>
<td>22.3</td>
</tr>
<tr>
<td>Very much</td>
<td>22</td>
<td>21.4</td>
</tr>
<tr>
<td>Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not received</td>
<td>73</td>
<td>70.8</td>
</tr>
<tr>
<td>Received</td>
<td>30</td>
<td>29.3</td>
</tr>
<tr>
<td>Information seeking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>47</td>
<td>45.6</td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td>54.4</td>
</tr>
<tr>
<td>Advisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>37</td>
<td>35.9</td>
</tr>
<tr>
<td>Yes</td>
<td>66</td>
<td>64.1</td>
</tr>
<tr>
<td>Supporter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>3</td>
<td>2.9</td>
</tr>
<tr>
<td>Family</td>
<td>87</td>
<td>84.5</td>
</tr>
<tr>
<td>Friend</td>
<td>11</td>
<td>10.7</td>
</tr>
<tr>
<td>Religion</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Financial support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not received</td>
<td>18</td>
<td>17.5</td>
</tr>
<tr>
<td>Received from a public agency</td>
<td>68</td>
<td>66.0</td>
</tr>
<tr>
<td>Received from relatives</td>
<td>17</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Note: $n = 103$
Discussion

Declining fertility transformed the extended families from an average of five members per household to only three persons at present and leads to the increasing proportion of elderly who are living alone or with only their elderly spouse. The type of elderly domicile is also affected by the economic status of the family. One-thirds of the elderly were living in households with income below the poverty line and the elderly who received economic support from their child(ren) had declined[2]. Therefore, a burden of caring for the elderly becomes a duty of other younger elderly in the same household. It might be that most of the elderly’s descendants must take a burden of earning income economically and the younger elderly in the family not only have to take care of themselves but also care for other elderly in household who need more care. However, according to traditional family practice, most of the caregiving for the elderly in household has been a burden of female caregivers, especially single, holding a status as a daughter or a wife[21]. Nevertheless, considering the ratio presented in this study, men are likely to care for the elderly substantially when compared with past practice, showing that the burden of care in several aspects fell solely on women.

In addition, it can be seen that caring for the elderly in the family mainly done by descendants by bloodline or by spouse creates a bond between the caregivers and the elderly, thus resulting in a good relationship between them although the elderly are in need

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Readiness of caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unhealthy/slightly unhealthy</td>
<td>8</td>
<td>10.7</td>
</tr>
<tr>
<td>Neither good or bad</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>Slightly healthy</td>
<td>77</td>
<td>53.3</td>
</tr>
<tr>
<td>Confidence of caring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not so much or little</td>
<td>48</td>
<td>46.7</td>
</tr>
<tr>
<td>Very much</td>
<td>55</td>
<td>53.3</td>
</tr>
<tr>
<td>Economic status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strained</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>Normal</td>
<td>37</td>
<td>65.1</td>
</tr>
<tr>
<td>Comfortable</td>
<td>27</td>
<td>26.2</td>
</tr>
<tr>
<td>2. Dependency of caring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dementia caregiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>51</td>
<td>49.5</td>
</tr>
<tr>
<td>No</td>
<td>52</td>
<td>50.5</td>
</tr>
<tr>
<td>Relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>76</td>
<td>73.8</td>
</tr>
<tr>
<td>Good</td>
<td>16</td>
<td>15.5</td>
</tr>
<tr>
<td>Not particularly good</td>
<td>11</td>
<td>10.7</td>
</tr>
<tr>
<td>Economic burden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>36</td>
<td>34.9</td>
</tr>
<tr>
<td>Some burden</td>
<td>35</td>
<td>34.0</td>
</tr>
<tr>
<td>Do not feel any burden</td>
<td>32</td>
<td>31.1</td>
</tr>
<tr>
<td>3. Stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None or little stress</td>
<td>77</td>
<td>74.8</td>
</tr>
<tr>
<td>Moderate stress</td>
<td>22</td>
<td>21.4</td>
</tr>
<tr>
<td>High stress</td>
<td>4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Notes: n = 103. Mean = 6.6; SD = 5.8
of intensive care or have communication problems. This is the reason why the relationship between caregivers and the elderly recipient played an important role to reduce or relieve stress among caregiving in this study, while the severity of behavioral problems like the elderly recipient with dementia was not associated with higher levels of caregiver stress[36].

Even though all these caregivers are not quite ready or well prepared for such a burden or for body of knowledge or for information regarding caregiving for the elderly, they still want and are willing to care for the elderly in the family because of the bonds between them as well as value of gratefulness which is the root in Thai society[6] and has been adhered to and observed within the community.

Most of the caregivers feel that caring for the elderly in household does not affect or create economic difficulty, partly because they are still able to earn income. Moreover, they have received a subsidy from external agencies or their kin, especially when they are also the elderly. Some of the caregivers not only earn their own income but also get subsistence allowance for themselves and for the elderly under care, thus making them feel that caregiving is not a great burden. However, the findings have revealed that the feeling of economic burden affects the feeling of stress for being a caregiver because each caregiver is in a different state of readiness for resources in caregiving for the elderly. Mostly, they are unpaid caregivers[13].

In the same way as for readiness of the caregivers’ health, most of the caregivers feel that they are still in good health and likely to be ready for caring for the elderly. However, it is likely that such readiness correlates with the stress in caregiving. It is also possible that some illnesses may occur during the period of caring for the elderly[14]. Moreover, the caregivers may feel that their health status may have an impact on their potential for caring

| Conditions                      | Perceived stress n (%) |  |  |
|---------------------------------|------------------------|  |  |
|                                 | None or little stress  | Moderate stress | High stress | p-value |
|                                 |                         |                      |             |         |
| **1. Readiness of the caregiver** |                         |                      |             |         |
| **Health condition**            |                         |                      |             |         |
| Unhealthy/slightly unhealthy    | 4 (50.0)                | 3 (37.5)             | 1 (12.5)    | 0.003*  |
| Neither good or bad             | 10 (55.6)               | 5 (27.8)             | 3 (16.7)    |         |
| Slightly healthy                | 63 (81.8)               | 14 (18.2)            | 0 (0.0)     |         |
| **Confidence of caring**        |                         |                      |             |         |
| Not so much or little           | 26 (54.2)               | 18 (37.5)            | 4 (8.3)     |         |
| Very much                       | 51 (92.7)               | 4 (7.3)              | 0 (0.0)     |         |
| **Economic condition**          |                         |                      |             | 0.591   |
| Strained                        | 6 (66.7)                | 2 (22.2)             | 1 (11.1)    |         |
| Normal                          | 51 (76.1)               | 13 (19.4)            | 3 (4.5)     |         |
| Comfortable                     | 20 (74.1)               | 7 (25.9)             | 0 (0.0)     |         |
| **2. Dependency of the elderly**|                         |                      |             |         |
| Elderly having dementia         |                         |                      |             | 0.159   |
| Yes                             | 34 (66.7)               | 14 (27.5)            | 3 (5.9)     |         |
| No                              | 43 (82.7)               | 8 (15.4)             | 1 (1.9)     |         |
| **Relationship condition**      |                         |                      |             | 0.000*  |
| Very good                       | 65 (85.5)               | 11 (14.5)            | 0 (0.0)     |         |
| Good                            | 9 (56.3)                | 7 (43.8)             | 0 (0.0)     |         |
| Not particularly good           | 3 (27.3)                | 4 (36.4)             | 4 (36.4)    |         |
| **Economic burden**             |                         |                      |             | 0.000*  |
| Very heavy/some                 | 18 (50.0)               | 14 (38.9)            | 4 (11.1)    |         |
| Not feel much                   | 30 (85.7)               | 5 (14.3)             | 0 (0.0)     |         |
| Not much                        | 29 (90.0)               | 3 (9.4)              | 0 (0.0)     |         |

**Note:** *Significance level α = 0.05

Table V. Relationship between conditions of caring and perceived stress of family caregivers
for the elderly because they have to take care of their own health at the same time. Nevertheless, this may be because if the caregiver perceived they have good health, they still enjoy their social life as necessary and do not have the feeling that caring for the elderly is a burden distracting them from social life. It is also another way to relieve their stress, and so, they are able to retain their privacy[29]. However, when compared to elderly caregivers in Japan, the condition of family caregivers was better in Thailand than in Japan. Despite there being a long-term care insurance system in Japan and not Thailand, Thai caregivers felt a lighter care burden and less loneliness, which relate to family caregivers in Thailand having more social connections and informal support than those in Japan[32]. All these are necessary for the work of caregiving for the elderly in the community that requires support at both the individual and community levels. Moreover, necessary resources in other aspects to help support and boost more confidence of these caregivers as well as an increase of capacity of the family in caring for the elderly[8] are extremely significant that family members, community, and society should place an importance on, because by doing so, it will not only lessen stress in being a caregiver but also help make the elderly be taken good and great care of by family members.

Recommendations
To reduce the stress of the elderly caregivers, readiness at an individual level and at the community level is required to support the caregivers in the family. This is because the caregivers with high confidence in caring for the elderly are likely to have less stress, and giving resources to enhance the confidence of caregivers is very important. Resources that will help strengthen confidence in caregiving may be in the form of materials, body of knowledge and enhancing mental stability. Furthermore, what the caregivers require most are additional knowledge, understanding or training in caregiving for the elderly properly in order to boost their confidence in caring for the elderly. In addition, the stress of caregivers can be decreased by reducing the caregivers’ economic burden in addition to subsistence allowance received on a regular basis through activities that increase the caregivers’ income, whereas they can still care for the elderly at home at the same time.

In order to relieve caregivers’ stress and improve the capacity of the elderly, it is necessary to create a system of long-term care operating by the community and collaboration among the community or a network of the family caregivers to build social support, understanding and exchange of experiences in caregiving as well as an emergency assistance system in the community in case that transfer of the elderly or urgent help is required.

References


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Exposure of chlorpyrifos in toddlers living in an agricultural area in Sakon Nakhon province, North-East Thailand

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College of Medicine and Public Health, Ubon Ratchathani University College, Ubon Ratchathani, Thailand  
Parichat Ong-artborirak  
College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand  
Mark Robson  
School of Environmental and Biological Sciences, Rutgers The State University of New Jersey, New Brunswick, New Jersey, USA, and  
Wattasit Siriwong  
College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand

Abstract

Purpose – Children living in agricultural areas are exposed to pesticides in their living areas and through activities of daily living. These exposures may lead to adverse health effects. The purpose of this paper is to investigate household environmental and behavioural factors associated with chlorpyrifos exposure and resultant adverse health effects in children living in an agricultural community.

Design/methodology/approach – A cross-sectional study was conducted including 65 toddlers (age of 12–36 months) and their parents were face-to-face interviewed from January to February 2016. Toddler’s hands and feet, toys and floors were wiped for chlorpyrifos residue analysis. The wipes were extracted and analysed by gas chromatography with a flame photometric detector, and blood cholinesterase activity was measured by the EQM Test-mate (model 400).

Findings – The average age (± standard deviation) of children was 19.9 (±5.9) months. Chlorpyrifos detections were 61.5 per cent (hands), 57.1 per cent (toys), 53.8 per cent (floors) and 30.8 per cent (feet). The highest chlorpyrifos residue concentration was detected on toy surface (3.022 µg/m2). Chlorpyrifos residues on hands and feet were positively correlated with concentrations on floors and toys (Spearman’s ρ, p < 0.01). Multiple linear regression analysis revealed that more frequent hand washing (β = −0.236, p = 0.067) and showering (β = −0.240, p = 0.056) was negatively associated with chlorpyrifos residue on children’s body. House cleaning frequency was significantly associated with an increase in haemoglobin-adjusted erythrocyte cholinesterase (β = 0.251, p < 0.05).
Introduction
Agriculture is the primary occupation in Thailand, and 46.54 per cent of the land area is devoted to agriculture. Most of agriculture area (63.85 per cent) is located in the northeastern part of the country[1]. Pesticides are commonly used in agriculture to control weeds, insects and diseases[2]. In 2010–2015, Thailand pesticide imports exceeded 130,000 tons per year[3]. Organophosphate (OP) insecticides are a group of chemical compounds that are highly toxic and used for the control insects for crop in agriculture, and they are highly toxic to nervous system and known as cholinesterase inhibitor[4]. Chlorpyrifos is a popular organophosphate insecticide that is intensively used in agricultural areas in Thailand[5]. The report case of pesticide poisonings in 2014 showed that toddlers under four years of age had a high incidence rate at the age of three[6]. Children are much more susceptible during different life stages owing to their dynamic growth and developmental processes as well as physiological, metabolic, behavioural differences and hygiene which may result in significantly greater exposures to environmental contaminants than adults[7]. Children have a larger skin surface area per kilogram body weight; therefore, they may have a higher chance of dermal exposure than adults[8]. Children who live in agricultural community have much higher exposure to pesticide more than children in non-farm areas[9–11]. Recreational activity in farming areas where pesticides have been used increases children’s exposure to pesticide. Hand-to-mouth and object-to-mouth (pica) behaviours in children aged one to three years old can also lead to increased pesticide exposure[12, 13]. Family members who work as farmers may bring home pesticide and contaminate the living environment with pesticide residues on clothes or shoes[8, 12, 14].

The measurements of OP exposure can be analysed by urinary metabolite concentration and blood cholinesterase level[15–18]. Similar to carbamate insecticide, OP is a potent inhibitor of cholinesterase, including erythrocyte cholinesterase (AChE) and plasma cholinesterase (PChE). The levels of AChE and PChE in blood samples are used to indicate cholinesterase activity which is related to acute or chronic health effects[14, 19]. The effect of chlorpyrifos exposure and residues on health symptoms may include contact dermatitis, nausea, sweating, diaphoresis, lacrimation, diarrhoea, salivation and headache[4].

Previous studies in Thailand have shown that children (six to eight years old) living in rice production areas had significantly higher urinary metabolite concentrations of OP than aquaculture farm children[20, 21]. Pre-school and school-aged children in Thailand had significantly higher urinary metabolite concentrations of OP exposure than the American children[11, 22, 23]. Based on the earlier studies, we can infer that Thai children are at significant risk from pesticide exposure, especially children who live in and around agricultural communities. This study investigated the association of chlorpyrifos residues and blood cholinesterase activity with behavioural factors among young children living in an agricultural community.

Materials and methods

Study area and participants
This study was cross-sectional in design that collected information on study exposure and outcome during the dry season (January to February 2016). It was conducted in an
agricultural area located in Khamin and Chaingkhruea sub-district, Muang Sakon Nakhon district, Sakon Nakhon province which is located in the northeastern part of Thailand. This region is agriculturally the most intense area that has been supported by irrigation to cultivate crops all year. Households in this area are surrounded by active agricultural activities that include the intensive use of chlorpyrifos. The major crops in this area are as follows: rice, watermelons, cantaloupes, chilies, cucumbers, canna flowers and vegetables[24]. Data from previous research were designed for calculating this study sample size[25] which was calculated by formula from Lemeshow et al.[26]. Approximately, 88 toddlers were randomized to 65 participants. Total of 65 toddlers aged between 12 and 36 months who born and live in agricultural area (distance from farming area to house < 50 m) were recruited by random sampling. If a family selected had more than 1 toddlers, the youngest one was selected because they were assumed to stay more in the house rather than going outdoor. Data were collected after toddlers and family caregivers received the study information and were enrolled as subjects. Informed consent was obtained by participant’s parents or caregivers. This study was approved by the ethics review committee for research involving human research subjects, health science group, Chulalongkorn University, Thailand (COA No. 221/2015).

Questionnaire. A structured questionnaire was used to interview parent or caregiver by face-to-face technique. The questionnaire was developed from Rohitrattana[25] including demographic information, children activities, environmental factors and health effects. And the validity was examined by three experts.

Sample collection. Wipe samples were collected from children’s hands, feet, floors/wooden beds and toys. Two 4 × 4 inch cotton gauzes wetted with 3 ml of 40 per cent isopropanol were prepared for wiping with modified technique from Clifton et al.[27] and Lu et al.[28]. The area for wipes sampling was based on answer from the questionnaire in children activities part. To collect the floors/wooden beds wipe samples, area 30 × 30 cm in the main living space was wiped by prepared gauze[29]. The toy wipe samples were wiped in 10 × 10 cm of surface areas[29]. Hands and feet wipe samples were collected by prepared gauzes, one gauze for each hand/foot side[28]. After that, the wipe sample was covered in aluminium foil and kept in a zip-lock bag. All samples were transported and analysed for chlorpyrifos at laboratory in the College of Public Health Sciences, Chulalongkorn University.

Wipe sample analysis. All surface wipe samples were extracted with modified technique from Anastassiades et al.[30]. The gauze pads wipe samples were added in Erlenmeyer flask with 25 ml acetonitrile (HPLC grade). Then, the sample was shaken for ten minutes, and gauze pads were separated from the solvent. Next, nitrogen gas 99.95 per cent was used for solvent vaporisation at 40 ± 2 °C to nearly dry off sample and 1 ml of 0.1 per cent acetic acid was added to acetonitrile. And then, the sample was removed to Eppendorf tube and added 25 mg of primary secondary amine (PSA) and 150 mg of MgSO4. The tube was mixed by vortex tool at 1 and 2 min at 6,000 rpm centrifugation for clean-up. Finally, the sample was sucked (liquid) to 1.5 ml vial for analysis of chlorpyrifos, cypermethrin and permethrin by gas chromatograph (GC). Chlorpyrifos concentrations analysis was performed by using an Agilent 7890 gas chromatography with a flame photometric detector (GC-FPD). A chromatography column HP-5 (30 m length, 0.250 mm diameter, 0.25 µm film thickness) was used. The column temperature was raised from 80 °C at 12 min to 195 °C, at 2 °C/min to 210 °C (held for 3 min), at 15 °C/min to 225 °C (held for 2 min), and at 40 °C/min to 275 °C (held for 7 min), respectively.

Quality control. Average recovery of chlorpyrifos by analysing ten replicates at two spiked levels (0.1 and 1.0 µg) was in the acceptable range (108.1 per cent) with relative standard deviation (SD) of 4.0 per cent. Correlation coefficient ($R^2$) from the calibration curves of chlorpyrifos concentrations with analysis of three replicates was shown to be 0.999.
Quality control for pesticide residues analysis was acceptable following the Guidelines for Residues Monitoring in the European Union[31]. The limit of detection (LOD) and limit of quantitation (LOQ) were estimated from the chromatograms at signal to noise ratio (S/N), i.e. 0.01 (µg/sample) for LOD and 0.02 (µg/sample) for LOQ.

Blood cholinesterase test. Blood cholinesterase level was used as a measure of chlorpyrifos exposure. Finger-stick blood samples were collected from participants and analysed with AChE, haemoglobin-adjusted erythrocyte cholinesterase (HAChE), and PChE by the EQM Test-mate ChE Cholinesterase Test System (Model 400), following standard procedures[32].

Data and statistical analysis. Statistical analysis was performed using SPSS statistical software package (IBM SPSS Statistics 22.0). Descriptive statistics were analysed including frequency, mean and SD. Chlorpyrifos residue concentrations as below the LOD were replaced with one-half of the LOD [33]. \( \chi^2 \) test was used for categorical variables. Spearman’s correlations were considered for pesticide concentration on hands, feet, floors/wooden beds and toys. A linear regression was performed for factors associated with pesticide concentrations.

Results

The demographic data of participants in this study are presented in Table I. There were a total of 65 toddlers in this study, 39 (60 per cent) boys and 26 (40 per cent) girls. Participants had mean ± SD of age 19.92 ± 5.99 months, height 78.91 ± 6.60 cm, weight 10.70 ± 1.93 kg and BMI 17.20 ± 2.50. The average of playing duration was 7.26 ± 1.73 h/day. Toddler’s behaviours included frequency of hand washing and shower, i.e. 3.86 ± 1.41 and 1.98 ± 0.54 times/day, respectively. Face touching and eating by bare hands were commonly found to be 55.4 and 67.7 per cent, respectively. Toddlers mostly spent time on house floor (52.3 per cent) and wooden bed (47.7 per cent) for their activities such as sitting, laying, sleeping, eating and playing. Residential environments showed everyday house cleaning (60 per cent), often window opening (63.1 per cent), house adjacent to farms (43.1 per cent) and exposed during pesticide spraying on farms (33.8 per cent).

The results of blood cholinesterase tests of participants are presented in Table II. The average of AChE was 2.38 ± 0.44 U/ml, HAChE 23.79 ± 4.76 U/g Hgb and PChE was 2.81 ± 0.81 U/ml.

For wipe samples, pesticide residues were collected from toddler’s hands and feet, floors/wooden beds and toddler’s toys. Concentrations of chlorpyrifos from surface wipe samples were typically detected on hands (61.5 per cent; 0.015 ± 0.026 µg/hands), followed by toys (57.14 per cent; 1.287 ± 0.757 µg/cm²), floors/wooden beds (53.8 per cent; 0.030 ± 0.022 µg/m²) and feet (30.8 per cent; 0.009 ± 0.006 µg/on feet), respectively (shown in Table III).

Since the chlorpyrifos residue concentrations were not normally distributed, Spearman’s correlation was considered to determine the relationship between chlorpyrifos residue concentrations on surface wipe samples. The results presented significantly positive associations among chlorpyrifos residue concentrations on hands, feet, floors/wooden beds and toy, and Spearman’s coefficient were in the range of 0.452–0.643 (p < 0.001) (Table IV).

Relationships between pesticide exposure and toddler’s activities, behaviours and residential environments are shown in Table V. Significantly increased chlorpyrifos residue concentrations were found on toddler’s feet who spent time on wooden beds (\( \beta = -0.72, p = 0.003 \)). The concentrations on hands and feet were decreased after hygienic behaviours such as hand washing and showing. Hand washing significantly could reduce the pesticide residue concentrations on toddler’s feet (\( \beta = -0.302, p = 0.022 \)). Showering can reduce chlorpyrifos residue concentrations on hands (\( \beta = -0.240, p = 0.056 \)) and feet (\( \beta = -0.236, p = 0.068 \)).
Toddlers’ behaviours like non-food taking to mouth were likely to be related to decreased PChE level ($\beta = -0.169, p = 0.213$). More frequent house cleaning was associated with high HACChE level ($\beta = 0.251, p = 0.049$). Results for the relationship between pesticide exposure and health effects were presented in Table VI. General health effects (nausea, vomiting and anorexia) were associated with PChE ($p = 0.018$). Skin health effects (skin irritation and diaphoresis) were
related to chlorpyrifos residue concentrations on hands and feet \((p = 0.052)\), while eye health effects (irritation and lacrimation) were related to chlorpyrifos residue concentrations on hands \((p = 0.077)\) and toys \((p = 0.086)\).

**Discussion**

The AChE levels among toddlers (one to three years old) living in agricultural area in this study \((2.38 \pm 0.44 \text{ U/mg})\) were lower than those in previous studies. Rohitrattana et al.[34] found that AChE of children aged six to eight years living in rice farms in Thailand was \(2.89 \pm 0.34 \text{ U/ml}\) for high pesticide use period. According to the study in Ecuador, Suarez-Lopez et al.[14] found AChE of \(3.08 \pm 0.51 \text{ U/ml}\) among children (four to nine years old) living with flower plantation workers. Furthermore, AChE in our study was lower than the study among Indonesia children having age of seven to eight years \((3.3 \pm 0.5 \text{ U/ml})\) living in agricultural villages[35]. This may be explained by AChE level increasing linearly with the age of children[14]. Also, this is due to the fact that toddlers spent more time at home and presumably with more exposure to any insecticides than the older ones.

### Table II.

**Blood cholinesterase level**

<table>
<thead>
<tr>
<th>Blood cholinesterase</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>AChE (U/ml)</td>
<td>2.38 ± 0.44</td>
<td>0.93-3.52</td>
<td>2.19</td>
<td>2.42</td>
<td>2.68</td>
<td>3.10</td>
</tr>
<tr>
<td>HACHE (U/g Hgb)</td>
<td>23.79 ± 4.76</td>
<td>9.90-40.20</td>
<td>21.30</td>
<td>23.90</td>
<td>26.00</td>
<td>32.16</td>
</tr>
<tr>
<td>PChE (U/ml)</td>
<td>2.81 ± 0.81</td>
<td>1.15-4.81</td>
<td>2.19</td>
<td>2.71</td>
<td>3.38</td>
<td>4.49</td>
</tr>
</tbody>
</table>

**Notes:** AChE, erythrocyte cholinesterase; HACHE, haemoglobin-adjusted erythrocyte cholinesterase; PChE, plasma cholinesterase

### Table III.

**Chlorpyrifos residue concentrations**

<table>
<thead>
<tr>
<th>Surface wipe samples</th>
<th>Detected frequency ((n = 65))</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands (µg/hands)</td>
<td>40 (61.5%)</td>
<td>0.015 ± 0.026</td>
<td>&lt; LOD</td>
<td>0.212</td>
<td>0.065</td>
<td>0.014</td>
<td>0.016</td>
<td>0.026</td>
</tr>
<tr>
<td>Toys* (µg/m²)</td>
<td>20 (30.8%)</td>
<td>1.287 ± 0.757</td>
<td>&lt; LOD</td>
<td>3.022</td>
<td>0.500</td>
<td>1.518</td>
<td>1.812</td>
<td>2.653</td>
</tr>
<tr>
<td>Floors/wooden beds (µg/m²)</td>
<td>35 (53.8%)</td>
<td>0.030 ± 0.022</td>
<td>&lt; LOD</td>
<td>0.006</td>
<td>0.010</td>
<td>0.033</td>
<td>0.041</td>
<td>0.081</td>
</tr>
<tr>
<td>Floors (µg/m²)</td>
<td>15 (23.0%)</td>
<td>0.024 ± 0.019</td>
<td>&lt; LOD</td>
<td>0.007</td>
<td>0.010</td>
<td>0.010</td>
<td>0.036</td>
<td>0.079</td>
</tr>
<tr>
<td>Wooden beds (µg/m²)</td>
<td>20 (30.8%)</td>
<td>0.036 ± 0.024</td>
<td>&lt; LOD</td>
<td>0.005</td>
<td>0.010</td>
<td>0.035</td>
<td>0.047</td>
<td>0.088</td>
</tr>
<tr>
<td>Feet (µg/feet)</td>
<td>20 (30.8%)</td>
<td>0.009 ± 0.006</td>
<td>&lt; LOD</td>
<td>0.032</td>
<td>0.005</td>
<td>0.005</td>
<td>0.015</td>
<td>0.019</td>
</tr>
</tbody>
</table>

**Notes:** *35 samples. LOD on hands = 0.01 µg/hands; LOD on feet = 0.01 µg/feet; LOD on floors or wooden beds = 0.02 µg/m²; LOD on toys = 1 µg/m²

### Table IV.

**Bivariate associations among chlorpyrifos residue concentrations on wipe samples**

<table>
<thead>
<tr>
<th>Spearman’s (\rho)</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands and feet</td>
<td>0.643</td>
</tr>
<tr>
<td>Hands and floors/wooden beds</td>
<td>0.533</td>
</tr>
<tr>
<td>Hand and toys</td>
<td>0.603</td>
</tr>
<tr>
<td>Feet and floors/wooden beds</td>
<td>0.521</td>
</tr>
<tr>
<td>Feet and toys</td>
<td>0.506</td>
</tr>
<tr>
<td>Floors/wooden beds and toys</td>
<td>0.452</td>
</tr>
</tbody>
</table>

**Note:** **\(p < 0.01\)**
behaviours and activities such as hand to mouth, object to mouth and playing on the floor may substantially increase the exposure to pesticide residue via multiple routes, oral and dermal[36, 37]. Differences in sociodemographic characteristics of these studies may be a potential factor on environmental exposure to pesticides[38].

The amounts of chlorpyrifos on hands were detected higher than those on feet. This might be due to more chance of exposure via hand contact with pesticide residue on toy, with found highest chlorpyrifos concentrations in this study, wooden bed/floor and other smooth surface such as furniture[37]. Floors/wooden beds wipe samples were detected with lower chlorpyrifos residue concentrations than toys wipe samples; this was because toddlers moved their toys everywhere (i.e. houses and farms) with them. There was a chance of toddler’s toys to contact soil or get exposed to pesticides in the farms. Pesticide residues on toys were collected from toddler’s toys; these are most favourite play items of children which may not be cleaned. Our result presented that chlorpyrifos residue concentrations on floors were detected slightly lower than on wooden beds. These findings agree with Qaundt et al.[39] that the floor may be source of the accumulation of pesticide residues in the household. The result can imply that the way Thai-house characters in rural area are commonly an opened-structure types with some add-on parts. Some houses do not have

<table>
<thead>
<tr>
<th>Activities</th>
<th>Chlorpyrifos residue concentrations</th>
<th>Blood cholinesterase levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hands</td>
<td>Feet</td>
</tr>
<tr>
<td>Playing duration (h/day)</td>
<td>0.009</td>
<td>0.944</td>
</tr>
<tr>
<td>Sitting/laying on floor or wooden bed</td>
<td>−0.149</td>
<td>0.234</td>
</tr>
<tr>
<td>Exposing during spraying</td>
<td>−0.080</td>
<td>0.541</td>
</tr>
<tr>
<td>Sleeping and playing duration</td>
<td>0.033</td>
<td>0.794</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behaviours</th>
<th>Chlorpyrifos residue concentrations</th>
<th>Blood cholinesterase levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hands</td>
<td>Feet</td>
</tr>
<tr>
<td>Frequency of hand wash (times)</td>
<td>−0.236</td>
<td>0.067</td>
</tr>
<tr>
<td>Frequency of shower (times)</td>
<td>−0.240</td>
<td>0.076</td>
</tr>
<tr>
<td>Face touching</td>
<td>−0.199</td>
<td>0.246</td>
</tr>
<tr>
<td>Taking non-food to mouth</td>
<td>−0.033</td>
<td>0.819</td>
</tr>
<tr>
<td>Taking food to mouth</td>
<td>0.077</td>
<td>0.558</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environments</th>
<th>Chlorpyrifos residue concentrations</th>
<th>Blood cholinesterase levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hands</td>
<td>Feet</td>
</tr>
<tr>
<td>Frequency of house cleaning</td>
<td>−0.133</td>
<td>0.299</td>
</tr>
<tr>
<td>Window opening</td>
<td>0.057</td>
<td>0.649</td>
</tr>
</tbody>
</table>

**Notes:** Significance was tested by linear regression. Adjust: surface area of hands and feet, age, gender for chlorpyrifos concentrations and age, gender for blood cholinesterase activity. *Significant at p < 0.05 level

<table>
<thead>
<tr>
<th>Health effects</th>
<th>Chlorpyrifos concentrations</th>
<th>Blood cholinesterase activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hands</td>
<td>Feet</td>
</tr>
<tr>
<td>General</td>
<td>0.542</td>
<td>0.896</td>
</tr>
<tr>
<td>Skin</td>
<td>0.130</td>
<td>0.047*</td>
</tr>
<tr>
<td>Eyes</td>
<td>0.077*</td>
<td>0.166a</td>
</tr>
<tr>
<td>Respiration</td>
<td>0.753</td>
<td>0.583</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>0.830</td>
<td>0.622</td>
</tr>
</tbody>
</table>

**Notes:** *Fisher’s exact test. χ² test. *p < 0.05

Table V. Relationships between chlorpyrifos residue concentrations and activities, behaviours and environments of children living in agricultural area, North-East Thailand

Table VI. Relationships between health effects and pesticide exposures

The amounts of chlorpyrifos on hands were detected higher than those on feet. This might be due to more chance of exposure via hand contact with pesticide residue on toy, with found highest chlorpyrifos concentrations in this study, wooden bed/floor and other smooth surface such as furniture[37]. Floors/wooden beds wipe samples were detected with lower chlorpyrifos residue concentrations than toys wipe samples; this was because toddlers moved their toys everywhere (i.e. houses and farms) with them. There was a chance of toddler’s toys to contact soil or get exposed to pesticides in the farms. Pesticide residues on toys were collected from toddler’s toys; these are most favourite play items of children which may not be cleaned. Our result presented that chlorpyrifos residue concentrations on floors were detected slightly lower than on wooden beds. These findings agree with Qaundt et al.[39] that the floor may be source of the accumulation of pesticide residues in the household. The result can imply that the way Thai-house characters in rural area are commonly an opened-structure types with some add-on parts. Some houses do not have
windows and doors; some houses have kitchen outside of the house, and some have terraces
and spaces. Thai houses are designed for daily activities. There are open spaces and
ventilation, which may increase pesticide exposures and dermal contract. Cleaning the
environments in which the toddlers live such as floor or wooden bed could remove the
pesticide residue; therefore, toddlers who stay on floor or wooden bed will be in less contact
with the pesticide residue. In this study, both of wet mop and bloom were used for house
cleaning. It is not enough to use a bloom to remove dust of pesticides on the floor/wooden
bed. Pesticide accumulation in houses increases by spraying pesticides in farms[40].

Toddlers play with or crawl into soil and come in contact with contaminated pesticide at
home surrounded by agricultural fields[41]. In addition, activity behaviours of toddlers such
as frequency of face touching and playing in fields were exposed to pesticides on their hands
and feet. Toddler’s hand-to-mouth contact is more frequent and eating by bare hands may
expose them to chlorpyrifos through ingestion. Chlorpyrifos residue concentrations in this
study was less than other research works[28, 39, 42], based on activities and behaviours
effects on pesticide exposures.

Linear association existed between pesticide exposure and daily activities of
participants. This was explained by the frequency of showering and hand washing
which decreased chlorpyrifos residue concentrations on hands and feet. The results shown
suggest a significant negative association between chlorpyrifos residue concentrations on
feet and playing duration as children may wear shoes and take a shower. Chlorpyrifos
residue concentrations on feet were detected to be lower than chlorpyrifos residue
concentrations on hands, floors/wooden beds and toys. However, chlorpyrifos residue
concentrations on feet were positively related to chlorpyrifos residue concentrations on
hands, floors/wooden beds and toys, which is similar to previous report of Quandt et al.[39].

Hand washing and showering were a protective factor for pesticide exposure [43]. Linear
regression models were adjusted for age and gender as factors associated to toddler’s
activities and behaviours. AChE activities can reflect organophosphates exposure, and age
and gender are related to activities and behaviour of toddlers[14]

Health effects of pesticide exposure in this study mirror the general health
effects including nausea, vomiting and anorexia that are related to PChE with acute
exposure referring to an intense exposure over a short time period[8]. Skin health
effects (skin irritation and diaphoresis) were associated with chlorpyrifos residue
concentrations on hands and feet that were from exposure to pesticides by dermal
contact. Chlorpyrifos residue concentrations on hands and toys were related to eye
irritation and lacrimation. This may be due to toddlers making hand contact to their eyes
and face. On further investigating, it was found that pesticides on toys also contribute to
children rubbing their eyes. These observations were similar to other study findings
on toddlers (< 6 years old) who are exposed to pesticides at homes from toxicity category
I and II pesticides[44]. Toddlers are susceptible and vulnerable to health effects from
pesticide exposure because of their physiological characteristics and age-related
behaviours[41].

Conclusions

Toddlers are exposed to pesticides by living in agricultural communities. Behavioural
factors among toddlers affect the chlorpyrifos residue concentrations on children’s
hands and feet. Toddlers are exposed to pesticides from floors/wooden beds and toys in
their living areas. Exposure to pesticides used in agriculture can affect blood cholinesterase
levels in toddlers. Toddlers may be at a risk from residential exposure to pesticide. Moreover, toddlers have additional exposure pathways by ingestion and inhalation. This
result suggests that toddlers should frequently wash their hands and take shower to reduce
pesticide on hand, feet and body. In addition, properly organised environment and good
personal hygiene practices, especially showering and hand washing, can prevent exposure to pesticide. The current study evaluated only pesticide exposure via dermal routes, mainly hands and feet. For further study, inhalation and ingestion routes should be investigated together with more specific biomarker, for example, urinary pesticide metabolite.

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Effectiveness of modified health belief model-based intervention to reduce body mass index for age in overweight junior high school students in Thailand

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Abstract

Purpose – The purpose of this paper is to determine the effectiveness of a modified HBM-based intervention to reduce body mass index (BMI) for age in overweight junior high school students.

Design/methodology/approach – A cluster-randomized controlled trial was conducted in the first and second years of a junior high school in the center of Thailand. In total, 24 classrooms were randomly assigned to a modified health belief model intervention arm (HBMIA), and 24 classrooms were randomly assigned to a traditional school health education arm (control). In total, 479 students who were overweight (BMI for age = median +1 SD, aged 12–15 years) participated in the study. The HBMIA used the health belief model (HBM) as a motivator for behavioral strategies that included modifying diet and participating in physical activity. BMI, health knowledge and behavior for preventing obesity were recorded at baseline and at six months. A multilevel regression model was performed to calculate mean difference between HBMIA and control group.

Findings – The students who participated in the HBMIA showed a decrease in BMI of 1.76 kg/m², while those who participated in the control showed an increase in BMI of 1.13 kg/m², with a mean difference of –2.88 kg/m² (95% CI = –3.01 to –2.75), an improvement in health knowledge (mean difference 27.28; 95% CI = 26.15–28.41) and an improvement in health behavior (mean difference 23.54; 95% CI = 22.60–24.48).

Originality/value – A modified HBM-based intervention to reduce BMI for age is effective in overweight junior high school students.

Keywords Overweight, Body mass index, Health belief model

Paper type Research paper

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Introduction

Obesity is a major global problem many countries face. Overweight and obesity are important risk factors for mortality and chronic disease[1]. Overweight and obesity also result in lower intelligence, slow learning, low immunity and increased risk of infection[2]. There has been a rapid increase in the prevalence of overweight adolescents in recent years. Overweight is now one of the most common adolescent health problems, and has significant adverse effects on physical and psychosocial health in adolescence and adulthood[3].

In Thailand early adolescence, the age between childhood and adolescence is a period of education at junior high school level. One of the most noticeable changes during this period is the rapid growth of almost every part of the body (the growth spurt) that takes place in the transition from childhood to adulthood. When the growth spurt starts, children tend to eat more, and their body accordingly increases accordingly. Weight gain depends on genetic factors, food consumption, exercise and gender[4]. If eating habits are not controlled by exercise, people will become overweight. Dietary control, an increase in body movement and exercise, and behavioral modification using parents as the role models of good health habits are effective treatment strategies for long-term weight control among juveniles[5, 6]. In addition, studies on weight control by implementing the body mass index (BMI) change program, using exercise along with dietary control, show that it can effectively reduce obesity. Based on studies abroad and in Thailand, weight control programs are effective, and participants can lose weight but not ensure behavioral changes over the long term[5, 6].

Previous studies have reported that the treatment of overweight adolescents has flaws in the methodology used, such as small sample sizes, high dropout rates, short-term follow-up, lack of detail about the randomization process, lack of blinding and failure to use intention-to-treat analysis[3, 7–9]. Intensive behavioral programs aimed at engineering change among overweight children have proved successful in clinical studies from one center in the USA[3, 7, 8]; however, because such interventions have been intense, they may not be readily generalizable to all health-care systems. Previous studies, therefore, have concluded that there is an urgent need for high-quality studies that test more generalizable intervention treatments among overweight adolescents[3, 7–9]. Nevertheless, previous studies have found that for a long-term weight control program to be effective, the parents should play a role in stimulating behavioral changes. Parents serve as a good role model and provide support to overweight adolescents[5, 6]. The recent studies presented above are consistent with concepts and theories that are useful as a basis for BMI-for-age changing programs for overweight junior high school students. They are also consistent with the health belief model (HBM), which provides motivation to change health behaviors.

Recent studies have found that HBM is useful in addressing many health problems. Among these are that it can improve the poor eating habits of pregnant women[10], prevent osteoporosis[11], prevent accidents among children younger than five years old[12] and increase patient compliance[13]. Recent studies have shown that health problems can be successfully solved by HBM because of the basic components of perception and motivation. If people are to avoid disease, they must believe there is a risk that the disease will severely affect their lifestyle; they must also believe that applying HBM may reduce the risk of disease or its severity[14, 15]. Overweight junior high school students are at higher risk of developing many health issues than their peers. These issues include non-communicable diseases, breathing problems, musculoskeletal discomfort and psychological problems. Among overweight junior high school students, 30 percent become obese adults[16]. Therefore, the aim of this cluster RCT was to examine the effectiveness of the modified HBM-based intervention for reducing BMI for age in overweight junior high school students, aged between 12 and 15 years. We also measured health knowledge and health behavior. The design, conduct and reporting of the trial followed the guidelines of Consolidated Standards of Reporting Trials (CONSORT)[17].
Materials

Human subjects approval statement

The research described in this study was conducted with the approval of the Human Research Protection Unit, Faculty of Medicine, Chulalongkorn University, IRB No. 551/59, in a meeting held on November 17, 2016. Participants received information about the research and were given the opportunity to ask questions before participating. The study has also been registered at clinicaltrials.gov under Trial No. NCT02904486.

Participants

This cluster-randomized controlled trial was conducted at the schools under Thailand’s Ministry of Education. The allocation of study conditions followed a two-step procedure. First, two schools were randomly selected from a list of all eligible schools. Second, 24 classrooms were randomly assigned to a modified health belief model intervention arm (HBMIA) and 24 classrooms were randomly assigned to a traditional school health education arm (control). Eligibility criteria for participants were students who were overweight (BMI-for-age $\geq$ median +1 SD) and were attending junior high school (first and second years) (aged 12–15 years). We excluded children who had an underlying medical cause of their excess weight or who had serious comorbidity that required urgent treatment, or who had received treatment for being overweight. Overweight students were recruited by researchers and school nurses. Written informed consent was obtained from all students and their parents/guardians.

Sample size calculations were performed to determine the number of students needed to detect 1.0 kg/m² difference between the HBMIA and control group. A sample of 205 per group was required to achieve 80 percent power with a two-tailed significance of 0.05, assuming an equal variance of 10.89 in both groups. Estimating a 10 percent dropout during the study, a minimum of 227 students per group was needed to reach the target of 205 students per group, as show in Figure 1.

Randomization and concealment

The overweight students attended a baseline assessment where the researcher obtained consent, recorded baseline measurements and assigned a study code. To ensure concealment, we produced a computer-generated randomization list and allocated the participants’ group classroom to the intervention or control group. Participants commenced intervention or control treatments within one week of the baseline measurements.

Intervention

HBM intervention arm. The program consisted of five main activities applied from the HBM and 11 appointments (nine student visits, one school director visit and one home visit) over a six-month period, with each contact session lasting 50 min. We used various behavioral change techniques to enhance the students’ motivation to make lifestyle changes. They were: first, “Perceived susceptibility of obesity”; students who were perceived susceptible to obesity were educated on “Obesity and Causes in Children” (using cartoon animation), and behavioral factors relating to their overweight were reviewed. Second, “Perceived severity of obesity” referred to the beliefs a person holds concerning the effects of obesity; this technique informed the children about these effects and educated them on the “Adverse Effect and Severity of Obesity in Children,” which enumerated the consequences of obesity in children in all aspects, such as health, family life and social life. In this regard, the researchers focused on using appropriate content for the child’s developmental age (using cartoon animation). Third, “Perceived benefit for the prevention of obesity”; students received books on health education and health behavior...
that showed them how to prevent obesity. Fourth, “Perceived barriers for the prevention of obesity”; students exchanged their experiences of the disadvantages or barriers they had to overcome in trying to change their behaviors. School management and teachers were invited to participate in arranging a proper environment for the practice. Finally, “Cues to action for the prevention of obesity”; we used a family-centered approach by visiting students’ homes to stimulate awareness and change behavior based on family support. Behavior should be changed for a period of at least six months to be effective[19-21]. Hence, this intervention was evaluated in the sixth month.

Students were encouraged to change their diet by reducing their intake of fatty foods and sugar, increase their intake of fruit and vegetables, increase their physical activity and restrict their sedentary behavior. Watching television and playing computer/video games were limited to no more than 2 h per day or the equivalent of 14 h per week, a period family members widely recommended and supported to help change their children’s behavior.

*Traditional school health education arm (control).* Students who were randomly assigned to the control group received a traditional school health education from the research team who, with teachers of general health education, collaborated to provide a standard intervention in the control group on the same day as the participants in the HBMIA.
Outcomes and blinding

The researcher recorded the outcome measures at baseline and then at six months after the start of the program. The participants were blinded to group allocation throughout the trial. Measures were put in place to ensure blinding, and the researcher had to report incidents of possible unblinding.

Our primary outcome was BMI. The researcher measured the weight, height and waist circumference of the students, who wore light indoor clothing and no socks and shoes. BMI for age was assessed in the range $\geq$ median $-1$ SD and $<\text{median} +1$ SD, which were recorded as normal, $\geq$ median $+1$ SD and $<\text{median} + 2$ SD, which were defined as the beginning of obesity or overweight, $\geq$ median $+2$ SD and $<\text{median} + 3$ SD, which were designated obesity and BMI $\geq$ median $+3$ SD, which was designated severe obesity[22].

We measured health knowledge and obesity prevention using a standardized questionnaire comprising six parts (35 questions) developed by the Health Education Division, Department of Health Service Support, Ministry of Public Health, Thailand (2016) which Cronbach’s $\alpha$ was 0.75[23].

Health behavior was measured using standardized questionnaires developed by the Health Education Division, Department of Health Service Support, Ministry of Public Health, Thailand (2016)[23]. We assessed the obesity prevention health behavior of participating students using a questionnaire with 20 questions to be scored on a five-level Likert scale. An assessment of a reliability test revealed a Cronbach’s $\alpha$ coefficient of 0.82.

Statistical analysis

Statistical analysis was performed on an intention-to-treat basis for each outcome measure, and involved all participants who attended for follow-up measures, regardless of whether they completed the treatment using data at baseline instead of value outcome at six months after the start of the program. Descriptive statistics were performed to determine the sociodemographic characteristics and physical examination of the study participants. Numbers and percentages are reported for categorical variables and means with standard deviations and ranges for continuous variables.

We calculated changes in BMI, health knowledge score and health behavior determinants from baseline to six-month follow up in HBMIA and control group. To compare the changed scores between the intervention group and the control group, we performed conditional multilevel regression model procedures after adjusting for baseline unbalanced variables (i.e. gender, GPA and parents’ education level), with schools and classroom included as random effects. We also performed a planned per-protocol analysis for outcome using only intervention and control participants who complied well and were involved in all the program’s sessions. All statistical analyses were conducted with STATA software version 15.0 (Stata Corp. 2017. Stata Statistical Software: Release 15. College Station, TX: Stata Corp LLC), and the level of significance was set at 0.05.

Results

In total, 479 overweight eligible students from 48 classrooms agreed to participate in the study. Out of those, 248 overweight students from 24 classrooms were randomly assigned to the HBMIA (intervention group) while 231 overweight students from other 24 classrooms were assigned to the SIA (control group). Of the 248 students who were randomly assigned to the intervention group, 247 (99.6 percent) completed the six-month follow-up. Of the 231 students who were randomly assigned to the control group, 229 (99.1 percent) completed the six-month follow-up (Figure 1). The sociodemographic characteristics and physical examination of the HBMIA and SIA participants were presented in Table I. Compared with the term group, the individuals assigned to HBMIA and SIA groups were similar in age, and they all lived close to a convenience store. The demographic analysis was conducted to
Effectiveness of modified HBM-based intervention

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>HBMIA (n = 248)</th>
<th>Control (n = 231)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>109 (44.0)</td>
<td>127 (55.0)</td>
</tr>
<tr>
<td>Female</td>
<td>139 (56.0)</td>
<td>104 (45.0)</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
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</tr>
<tr>
<td>Mean ± SD</td>
<td>13.70 ± 0.74</td>
<td>13.76 ± 0.76</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>11.83 – 15.75</td>
<td>12.00 – 15.50</td>
</tr>
<tr>
<td><strong>GPA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.77 ± 0.63</td>
<td>2.62 ± 0.59</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>1.11 – 3.98</td>
<td>1.04 – 3.89</td>
</tr>
<tr>
<td><strong>House closed to a convenience store</strong></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>161 (64.9)</td>
<td>161 (69.7)</td>
</tr>
<tr>
<td>No</td>
<td>87 (35.1)</td>
<td>70 (30.3)</td>
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<tr>
<td><strong>Parent’s education level</strong></td>
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<tr>
<td>Under junior high school</td>
<td>32 (12.9)</td>
<td>51 (22.1)</td>
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<tr>
<td>Junior high school</td>
<td>34 (13.7)</td>
<td>40 (17.3)</td>
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<tr>
<td>Senior high school</td>
<td>83 (33.5)</td>
<td>81 (35.1)</td>
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<tr>
<td>Diploma</td>
<td>24 (9.7)</td>
<td>17 (7.4)</td>
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<td>Bachelor’s degree and postgraduate</td>
<td>75 (30.2)</td>
<td>42 (18.1)</td>
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<td><strong>Family’s economic status</strong></td>
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<tr>
<td>Sufficient with moderate amount of savings</td>
<td>196 (79.0)</td>
<td>181 (78.4)</td>
</tr>
<tr>
<td>Sufficient with almost no savings</td>
<td>36 (14.5)</td>
<td>35 (15.2)</td>
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<tr>
<td>Not sufficient with some debts</td>
<td>14 (5.7)</td>
<td>13 (5.5)</td>
</tr>
<tr>
<td>Not sufficient with high amount of debts</td>
<td>2 (0.8)</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td><strong>Body mass index (kg/m²)</strong></td>
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<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>27.16 ± 4.33</td>
<td>27.53 ± 4.42</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>20.81 – 44.73</td>
<td>21.30 – 48.36</td>
</tr>
<tr>
<td><strong>Z-score of BMI for age (kg/m²)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>⩾ Median + 1 SD and &lt; median + 2 SD (overweight)</td>
<td>109 (44.0)</td>
<td>96 (41.6)</td>
</tr>
<tr>
<td>⩾ Median + 2 SD and &lt; median + 3 SD (Obesity)</td>
<td>110 (44.3)</td>
<td>106 (45.9)</td>
</tr>
<tr>
<td>⩾ Median + 3 SD (severe obesity)</td>
<td>29 (11.7)</td>
<td>29 (12.5)</td>
</tr>
</tbody>
</table>

Table I. Baseline characteristics of participants

Determine the family’s economic status, the participants’ BMI and the Z-scores for BMI for age. The two groups differed in the sociodemographic characteristics (i.e. in terms of gender, GPA and parents’ education level).

In the primary intention-to-treat analysis, significant differences were observed between the HBMIA and control groups in terms of BMI, health knowledge score and health behavior score from baseline to six months. These differences are presented in Table II. The BMI score among the HBMIA group decreased (−1.76 kg/m²), while the control group showed a BMI increase (1.13 kg/m²), with an unadjusted mean difference of −2.89 mg/m² (95% CI = −3.01 to −2.76) and an adjusted mean difference of −2.88 mg/m² (95% CI = −3.01 to −2.75). Regarding the change in health knowledge and health behavior, health knowledge increased among the HBMIA participants (25.12) but decreased among the control group (−1.59), with an unadjusted mean difference of 26.71 (95% CI = 25.59–27.82) and an adjusted mean difference of 27.28 (95% CI = 26.15–28.41). Health behavior scores increased in the HBMIA group (21.18), while those in the control group decreased (−2.10), with an unadjusted mean difference of 23.28 (95% CI = 22.37–24.19) and an adjusted mean difference of 23.54 (95% CI = 22.60–24.48) (Table II).
We also performed a per-protocol analysis for score changes in BMI, health knowledge and health behavior using only intervention and control participants who complied with all sessions in the program and fully committed to it; 247 participants were included in the analysis on HBMIA at six months, and 229 participants were included in the analysis on control group at six months. The results were more likely to be intention-to-treat analysis.

**Discussion**

We are among the first study in Thailand to examine a best-practices program and home visit based on a modified HBM applied to prevent and reduce overweight among junior high school students. The intervention program based on the generalizable modified HBM tested in this study showed significant benefits in terms of BMI reduction and increased health knowledge and health behavior. Furthermore, for participants who complied well with the program, the outcomes were significantly higher in the HBMIA group compared with the control subjects from baseline to six months. However, at six months, we observed no improvement in BMI, health knowledge and health behavior among overweight students receiving standard care (control group). The significant benefits observed in reduced BMI and increased health knowledge and health behavior in the HBMIA group may reflect differences in treatment targets: our HBMIA focused on diet, physical activity and reducing sedentary behavior to achieve change via the HBM, whereas standard care had minimal emphasis on motivating behavioral change through diet and physical activity. Furthermore, standard care did not target sedentary behavior. This study, therefore, provides some evidence that the inclusion of these behavioral change targets as part of treatment is worthwhile, even though the changes in activity behavior were moderate. There is widespread concern, particularly from parents, that treating overweight students may increase the risk of adverse effects; however, research in this area is limited[3, 24]. We found that our modified HBM-based intervention program, which included the support of family, the schools, teachers and society, did not adversely affect the students’ growth or quality of life.

| Table II. | Comparison of effectiveness among participants who received HBMIA and those who received control |
| Main variables | HBMIA (n = 248) | Control (n = 231) | Unadjusted mean differences
d(95% CI) | Adjusted mean differencesa,d(95% CI) |
<table>
<thead>
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</thead>
<tbody>
<tr>
<td><strong>Body mass index (kg/m²)</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>27.16±4.33</td>
<td>27.53±4.42</td>
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<tr>
<td>6 months</td>
<td>25.40±4.35</td>
<td>28.66±4.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changec</td>
<td>-1.76±0.76</td>
<td>1.13±0.62</td>
<td>-2.89 (−3.01, −2.76)</td>
<td>-2.88 (−3.01, −2.75)</td>
</tr>
<tr>
<td><strong>Health knowledge score</strong> (score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>86.05±12.86</td>
<td>83.58±12.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>111.17±6.18</td>
<td>81.99±11.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changec</td>
<td>25.12±8.17</td>
<td>-15.9±2.98</td>
<td>26.71 (25.59, 27.82)</td>
<td>27.28 (26.15, 28.41)</td>
</tr>
<tr>
<td><strong>Health behavior</strong> (score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>63.88±7.89</td>
<td>63.30±8.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>85.06±5.96</td>
<td>61.20±7.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changec</td>
<td>21.18±6.25</td>
<td>-21.0±5.39</td>
<td>23.28 (22.37, 24.19)</td>
<td>23.54 (22.60, 24.48)</td>
</tr>
</tbody>
</table>

Notes: Data were analyzed as intention to treat. *Adjusted by gender, academic achievement (GPA) and parents’ education level; ^including health knowledge of obesity prevention, access to information and health services, communication to increase expertise, managing self-health conditions, understanding the media and information, and making the right decision; change = 6 months – baseline; mean differences = HBMIA – control
We found that the modified HBM-based intervention program was successful in contrast with the no-treatment control group. Previous studies in Scotland and Denmark have shown that BMI z-scores decreased significantly among overweight children who received treatment over 12 months[3, 25]. In contrast, this study found significant decreases in BMI at six months in the HBMIA group[19–21]; furthermore, the clinical significance of these changes is clear because evidence from the modified HBM-based intervention program suggests that students’ beliefs about health problems and the perceived benefits and barriers to changing their behavior and self-efficacy explain their engagement (or lack of engagement) in health-promoting behavior, because they serve as a stimulus for the students to change their behavior and maintain health-promoting behavior[26]. The results of the BMI measurements at six months clearly show that the students consequently had increased knowledge and achieved behavioral changes to help them prevent obesity. It is possible that the students’ motivation to change their behavior involved stakeholder support in solving problems; therefore, family, the schools, teachers and society in this study were more resistant to the program[5, 6, 27, 28]. We also provided cooperation and support to the participants during the whole period of six months.

In addition, treatment programs that use an HBM to change students’ lifestyle are more likely to be successful in the treatment of overweight children[29–31]; therefore, we used this HBM to develop a generalizable, HBM-based intervention delivered by a researcher and school nurses in a school setting, thereby making the manpower burden and treatment costs generalizable. We also ensured that the HBM modified in the intervention was of a very high quality. The intervention group researcher team was highly trained in counseling children on behavioral change[32].

Interestingly, the results of the present study show that most of the students in both groups lived close to a convenience store, and the family’s economic status was sufficient. It can be seen that in both groups the factors affecting obesity were similar. Thus, it was possible that the causes of obesity in this study are related to the students’ social and environmental factors. Previous studies have reported that society and the environment promote overweight and obesity. Also, the chances of finding obese children are higher in urban societies than in rural societies. In urban societies, there is more competition; therefore, children’s behavior in their leisure time changes. Children need to take extra lessons, which negatively influence their exercise time. As a result, the balance between energy consumption and total consumption becomes disrupted, leading to what is called an obesogenic environment[33, 34], which includes parental education and family economic status[35]. In higher-income families, obesity rates are higher[36].

This study has several strengths, including the relatively large sample of the intervention and the control group and the fact that we used only a well-trained, calibrated and blinded school nurse to examine all participants. The high retention rates for the intervention and control group (99.6 and 99.1 percent) also served to attenuate concerns about compliance using intention-to-treat analysis and properly conducted randomization procedures. However, several limitations should be acknowledged when interpreting the results of our study. First, this study was an intervention program that was relatively intensive and short compared to other studies, which were of longer duration. Therefore, it was possible that the participants were biased and the measures outcome errors. It is possible that a more intense intervention of longer duration than the one used in this study may have been more successful, but our aim was to test an intervention that was practical and thus likely to be generally applicable. Alternatively, the family support applied at home during the intervention may have allowed families to set lifestyle goals that affected health knowledge and health behavior.
Conclusions

The HBM modified for intervention had the benefit of reducing the BMI for age among overweight junior high school students who complied with the program. It also improved the participants’ knowledge about health and their health behavior. Although such a program may not be realistic for many health-care systems, our findings may be useful in the development of future treatment programs. More research may be needed to provide various activities for inclusion in the HBM intervention program. It could also be useful to apply the model to different targets, such as overweight primary school students, obese diabetic patients, etc.

Acknowledgments

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References


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Arnond Vorayingyong can be contacted at: arnond.v@gmail.com
Pesticide use and environmental contamination a study in Khao Koh District, Phetchabun Province, Thailand

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Department of Environmental Health, Faculty of Public Health, Naresuan University, Phitsanulok, Thailand

Abstract

Purpose – The purpose of this paper is to explore environmental contamination from pesticide use in a Khao Kho Sub-district, Khao Kho District in Phetchabun Province, Thailand.

Design/methodology/approach – The study area was made up of four villages: Kanok Ngam, Lao Lue, Lao Neng and Phet Dam, all mostly highland areas whose inhabitants are mainly from the hill tribes. The 548 participants were recruited with inclusion criteria being that they must be living in the area over one year and are agriculturists or relevant who use pesticides. The data collection was divided into two parts: first, population data using a questionnaire; and second, samples of environmental media including agricultural products gathered to analyze the contamination of pesticides. The data were analyzed using descriptive statistics.

Findings – The most planted crop was rice (53.52 percent). Regarding agricultural chemical uses, the study found that the majority of participants used herbicides (76.83 percent). In terms of herbicide uses, Glyphosate is the most used (39.59 percent). Furthermore, insecticide consumption uses were higher in Phet Dam village than the other villages. The most common uses were Carbaryl (20.66 percent), followed by β-Betoefluthrin (15.49 percent).

Originality/value – There were glyphosate and derivatives of glyphosate (Aminomethyl Phosphonic Acid) in soil and sediment samples, while herbicides and insecticides were not found in water and agricultural samples. Because these environmental contaminants are a major cause for health problems amongst producers and consumers alike, agriculturists should be supported by relevant organizations to increase organic crop cultivation methods and organic farming networks.

Keywords Pesticide residues, Pesticide use, Glyphosate

Paper type Research paper

Introduction

At present, chemical usage in agriculture is widespread, especially among European and Asian countries including Thailand. The Office of Agricultural Economics[1] reported that Thailand imported 198,317 tons of hazardous agricultural chemicals which estimatedly cost 27,922 million Baht in the year 2017. Among these, the top three imported pesticides from the year 2011–2017 were revealed to be herbicides, insecticides and fungicides, respectively. In 2017, the top-five imported herbicides were glyphosate isopropylammonium, Paraquat dichloride, 2,4-D-dimethylammonium, Atrazine and Ametryn. Also, the top-five imported insecticides were recorded to be Chlorpyrifos, Cypermethrin, Carbaryl, Carbosulfan and Cartap hydrochloride[2]. In 2016, there were 8,689 patients suffering from pesticide-related health effects with a morbidity rate of 14.47 per 100,000. In total, 70.81 percent of them were in the 15–59 age group. From 2010 to 2015, the morbidity rate (caused by pesticides) increased from...
Moreover, Phetchabun Province was ranked third amongst the number of patients affected by pesticide-related medical conditions. Phetchabun Province is located in the lower northern region of Thailand which geographically slopes from the north toward the south. 45.78 percent of the land is covered in forests. Phetchabun has 11 districts: Mueang Phetchabun, Lom Sak, Chon Daen, Nong Phai, Bueng Sam Phan, Wichian Buri, Si Thep, Wang Pong, Nam Nao and Khao Kho. Khao Kho is a district located in the north of Phetchabun and is in the high land region[4]. Khao Kho sub district is located in the west of Phetchabun Province. The area is about 1,333 square kilometers or about 833,125 Rai of which 73,608 Rai is agricultural land[5]. Some of this land is very steep at 500–1,400 meters height above sea level.

The population residing in Khao Kho sub-district consists of the hill tribes, namely, the Hmong, Yao and Lisu. They mostly earn a living by cultivation and use agricultural chemicals currently used widely such as chemical fertilizers, plant hormones, herbicides and insecticides to speed up the growth of plants, increase agricultural productivity and to kill pests. These chemicals not only deteriorate natural resources and environments in agricultural areas but also leave residues and contamination in crops[5]. The sub-district health promotional hospitals in Khao Kho district reported that more than 40 percent of people, made up mostly of hill tribe people, were at increased dangerous risk of illness from exposure to chemicals. Half of them possessed test results showing unsafe levels[6]. The aim of this research paper was to conduct a study about environmental problems caused by pesticide usage of people living in the highlands at Khao Kho Sub-district, Khao Kho District, Phetchabun Province in Thailand.

Methodology

Research design

This cross-sectional study aimed to explore environmental contamination from pesticide use in the Khao Kho sub-district of Khao Kho District, Phetchabun Province. The study area was comprised of four villages: Kanok Ngam, Lao Lue, Lao Neng and Phet Dam which are highland areas comprising people belonging to the hill tribes (Hmong, Yao, Lisu). A total of 548 agriculturists were recruited as participants through random sampling with inclusion criteria being that participants had to have lived in the area over one year and had to be agriculturists or working in relevant fields involving pesticide usage.

The data collection was divided into two parts: first, population data were collected using a questionnaire which contained general data of villages such as personal data, socioeconomic data, kinds of cultivated plants, duration of growing plants (land preparation until harvest), and chemical usage in terms of types and quantity. The validity of the research tool was 0.67 – 1. Second, the 27 samples of environmental media including soil, water, sediment and agricultural products were gathered to analyze the contamination of pesticides.

Steps taken in conducting a study shown as Figure 1.

Sample groups

Soil samples from farmlands. The size of farmland was used to determine the number of soil sampling using simple random sampling techniques. According to the criteria of the National Environment Board, Pollution Control Department, BE 2547[7] it was determined that ten sampling points should be surveyed in every 3.953 Acres (10 Rais) using simple random sampling. In each sampling point, the soil samples were collected in the same quantity and gathered into one sample for that area. A depth for collecting soil layer samples was about 15 centimeters or 6 inches by digging a V shape. Soil samples from the random sampling in each unit area were then collected in a container. The soil samples were spread on a canvas to get rid of moisture and then divided into 4 parts, known as a quartering procedure. Two parts of soil which were opposite to each other (about 500 grams – 1 kg) were collected into a
wide-mouthed amber colored glass bottle to prevent sunlight as the best representative soil and sent to a laboratory.

*Water samples.* The water samples were collected from water resources in nearby agricultural areas which are reservoirs for consumption and agricultural activity. The sampling point was chosen from two points using the grab sampling technique[8]. First, the upstream point was used as a reference sample because there was no agricultural activity in this area. Second, the downstream point was used to indicate agricultural chemical distribution including samples from water sources which were used for tap water. The water samples were kept in borosilicate glass at temperatures below 4°C and sent to a laboratory.

*Sediment samples.* The composite sampling technique was used for collecting sediment samples with a depth between 0 and 6 inches from water resources near agricultural areas. The sediment samples were kept in a black container. The sediment samples were dried using a freeze dryer and sent to a laboratory.

*Agricultural product samples.* The sample of agricultural products; rice, maize, ginger, and radish, were collected in edible parts using the random subsample technique. The sampling period was the harvest season. The agricultural product samples were kept in black containers at temperatures below 4°C to prevent sunlight and sent to a laboratory for residue agricultural chemicals analysis.

**Results**

**Demographic characteristics**
The study found that the majority of workers were male (69.7 percent), whose average age was 46.12 years (SD = 12.257) with participant ages ranging from 21 to 87 years. Almost all of them were married (85.6 percent). The average number of family members was 5.83 (SD = 3.213) and ranged between 1 and 21 members. In total, 88.0 percent of the participants had not had chronic disease by diagnosis and 88.5 percent of the participants did not take medicine regularly. Also, 82.3 percent of participants never had any illness until they stopped working in the past 12 months. Regarding occupational issues, the top-three problems included the price of agricultural chemicals (fertilizers/insecticides/herbicides/fungicide), pest/pestilence and soil deterioration which was 76.4, 74.3 and 68.6 percent, respectively, as shown in Table I.

**Agricultural chemicals use**
The study found that the most popular crop was rice (53.52 percent). The others were maize, ginger, radish and chilli at 24.93, 6.34, 5.35 and 3.94 percent, respectively, as shown in Figure 2.
<table>
<thead>
<tr>
<th>Variables</th>
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<tbody>
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<td>Female</td>
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<td>Mean = 46.12, SD = 12.257, Max. = 87, Min. = 21</td>
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<tr>
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<td>Mean = 5.83, SD = 3.213, Max. = 21, Min. = 1</td>
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<tr>
<td>No</td>
<td>468</td>
<td>88.0</td>
</tr>
<tr>
<td>Yes</td>
<td>64</td>
<td>12.0</td>
</tr>
<tr>
<td>Taking medicines for treating chronic disease (529)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>468</td>
<td>88.5</td>
</tr>
<tr>
<td>Yes</td>
<td>61</td>
<td>11.5</td>
</tr>
<tr>
<td>Could not work because of illness within a year (531)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>437</td>
<td>82.2</td>
</tr>
<tr>
<td>Ever</td>
<td>94</td>
<td>17.7</td>
</tr>
<tr>
<td>Occupation related problems (440)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expensive agricultural chemicals (Fertilizer/Insecticide/Herbicide and Fungicide)</td>
<td>336</td>
<td>76.4</td>
</tr>
<tr>
<td>Pest infestation</td>
<td>327</td>
<td>74.3</td>
</tr>
<tr>
<td>Soil degeneration</td>
<td>302</td>
<td>68.6</td>
</tr>
<tr>
<td>Low yield</td>
<td>270</td>
<td>61.4</td>
</tr>
<tr>
<td>Lack of knowledge of chemicals used</td>
<td>164</td>
<td>37.3</td>
</tr>
<tr>
<td>Lack of water</td>
<td>64</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Table I. Number and percentage of research populations

Figure 2. Percentage of the top five crops in the study area
It also found that radish was popularly planted in the Phet Dam village. This plant used insecticides more than other plants. Therefore, insecticide consumption was used more in the Phet Dam village than the others (Figure 2).

In terms of agricultural chemical use, the study found that the majority of participants used herbicides (76.83 percent), followed by insecticides and fungicide at 15.42 and 7.75 percent, respectively (Figure 3).

Regarding herbicide use, the study found that Glyphosate was the most used (39.59 percent), followed by Metsulfuron-methyl, Paraquat, and mixed Chlorimuron-ethyl + Metsulfuron-methyl, and Atrazine at 26.11, 14.33, 10.46 and 6.31 percent, respectively.

In terms of insecticide use, the study found that insecticide consumption was used more frequently in the Phet Dam village than others. The most common uses were Carbaryl (20.66 percent), followed by β-Betofluthrin, Carbofuran and Abamectin at 15.49, 7.51 and 6.57 percent, respectively.

**Environmental contamination**

**Soil samples**
Six samples; S001, S002, S003, S004, S005 and S006, were collected from farmland. Most of the soil samples had pH 4.12–4.71 with the range of cation exchange capacity being 5.09–7.90 cmolc/kg and organic matter being 2.36–2.79 g/100 g (%w/w). These indicated that soil fertility was at a moderate level [9]. The results showed that glyphosate residues were found to be higher in sample numbers S001, S003 and S005 than Aminomethyl Phosphonic Acid (AMPA) which are derivatives of glyphosate. On the other hand, AMPA levels were found to be higher in sample numbers S002, S004 and S006 (Figure 4). However, the Paraquat, Abamectin and Carbamate groups were not detected with the limit of detection (LOD) being 0.05 mg/kg, 0.01 mg/kg, and 0.01 mg/kg, respectively.

**Water samples**
Ten water samples were collected and results found that both herbicides and insecticides were not detected. The LOD of Abamectin, Paraquat, Glyphosate and Carbamate group were 0.005 mg/L, 0.01 mg/L, 0.005 mg/L and 0.0001 mg/L, respectively.

**Sediment samples**
The study showed that Glyphosate residues and AMPA residues were found in the four sediment samples. All samples contained glyphosate residues ranging from 40 to 420 μg/kg and AMPA residues ranged from 20 to 270 μg/kg as shown in Figure 5. Moreover, the highest residue levels of both glyphosate and AMPA were found in sample SD003 which was collected from the water source for supplying the village with water.
Agricultural product samples
The study found that both the residual insecticide and herbicide levels were not detected in all samples. The LOD of glyphosate, paraquat, abamectin and carbamate groups were 0.01 mg/kg, 0.01 mg/kg, 0.01 mg/kg and 0.005 mg/kg, respectively.

Discussion
Soil samples
The results showed that glyphosate and AMPA were detected in soil samples, which might be because hill tribe agriculturists most commonly use glyphosate which can be biodegraded by microorganisms attributed to derivatives of glyphosate (AMPA). These findings are consistent with Battaglin et al.[10] who found that microorganisms mainly contribute glyphosate to AMPA. The half-life of AMPA is 60–240 days and can be decomposed to inorganic phosphate, ammonium ions and carbon dioxide eventually.

According to the World Health Organization statement in 1994[11], glyphosate accumulation in the soil will be increased and the numbers of earthworms tend to decrease if agriculturists used glyphosate continuously and/or in increasing amounts. A few studies found that glyphosate residue in the soil affects cucumber seedling growth with the highest toxicity found in mixed glyphosate soil. Furthermore, there is no difference of level of toxicity between 0 and 60 days[12, 13]. In addition, if the amount of glyphosate is over 500 mg/kg, it can affect or be toxic to earthworms and microorganisms.
Water samples
Glyphosate was not detected in water samples, which might be because the glyphosate moved to bind with suspended particles in water and dropped into the water that turned to sediment which is consistent with Kirkwood[14] where it was found that glyphosate could disappear from treated water by dilution or adsorption to bottom sediments. With reference to the Joint FAO/WHO Meeting on Pesticide Residues in 1998[15], the working party recommended an acceptable daily intake of glyphosate or AMPA at 0.3 mg/kg body weight and for drinking water standards must not exceed 0.9 mg/L whereas the default assumption for adult body weight is 60 kg per 2 liters of drinking water.

Sediment samples
Glyphosate is the agricultural chemical most often used to prepare the soil for cultivation. There was a chance that the chemicals will be eroded into the river as well as the soil that has anionic properties that can be bound with Glyphosate which can have a half-life in the soil for 3–130 days[13, 16]. Also, it is consistent with Watts[17] where it is stated that glyphosate was detected in sediment in the sea in New Zealand possibly caused by spraying glyphosate to kill grass on the street. Moreover, derivatives of glyphosate can be found regularly as glyphosate can be degraded by microorganisms[18].

Agricultural product samples
According to the study of Glass[19], glyphosate can be bound with soil particles. This affects plants and cannot be absorbed into the stem while it can be absorbed through the leaves. However, the agricultural product samples were collected in a single-period. Therefore, the results showed that the residue of pesticides were not detected and cannot be used to confirm the residue of pesticides in agricultural production.

Health impacts
The use of glyphosate and its slow rate of decomposition that causes the breakdown product AMPA in the soil, water, and sediment as well as the accumulation of glyphosate in the environment affects our health. The International Agency for Research on Cancer[20] reclassified glyphosate as category 2A: probably carcinogenic to humans. Additionally, various studies have documented the negative impacts of exposure to glyphosate on human health. According to the study of Fortes et al.[21], frequent use of pesticides (once a month or more vs less than once a month) was associated with an increased risk of melanoma, although this is not statistically significant. However, the use of pesticides for ten years or more was associated with a seven times increased risk of melanoma (OR 7.40). Exposure to at least two types of pesticides was associated with four times the increased risk of melanoma (OR 4.04). After controlling for all possible confounders, an increased risk for melanoma was associated with the use of herbicides (OR 3.08). While, a panel study of Adriana Camacho and Daniel Mejia[22] indicated that exposure to the glyphosate in aerial spraying campaigns increases the number of medical consultations related to dermatological and respiratory illnesses, as well as the number of miscarriages.

Fluegge and Fluegge[23] found that a 1 kg increase in glyphosate use in one year positively predicts state-level all-listed attention-deficit hyperactivity disorder (ADHD) discharge diagnoses the following year (coefficient = 5.54E-08, p < 0.01) and the effects of urbanization on the relationship between glyphosate use and ADHD indicates that the relationship is marginally significantly positive in urban US cities (p < 0.025). Also, correlations have been found between increased glyphosate use and a wide variety of human diseases, including various forms of cancer, kidney damage and mental conditions such as ADHD, autism, Alzheimer’s and Parkinson’s disease[24].
Furthermore, glyphosate may contribute to gut dysfunction and the development of celiac disease by inhibiting the breakdown of proteins such as gluten. There was evidence to suggest that the herbicide compromises commensal gut flora and, through various mechanisms, contributes to microvilli damage and nutrient malabsorption including impaired neurotransmitter production[25, 26]. Several studies found an increased risk for non-Hodgkin’s lymphoma in individuals who were occupationally exposed to pesticides or herbicides, including glyphosate, in the USA, Canada and Sweden; testing for glyphosate, which was conducted through blood and urine, detected glyphosate at high levels in agricultural workers and showed a dose-dependent response. In addition, one study also found an increase in micronuclei, a blood marker for genotoxicity, chromosomal damage and cellular oxidative stress in residents of communities where glyphosate was sprayed[20]. Moreover, glyphosate has been shown to also affect other functions of the body such as defective insulin receptor functions[27].

While human trials examining glyphosate toxicity and cancer are still limited, we should still take into consideration glyphosate’s effects on rats and mice and the possibility that some of these effects could be relevant for humans as well. Several studies have found renal tubule carcinoma, haemangiosarcoma, skin tumors and pancreatic islet-cell adenoma in animals experimentally exposed to glyphosate[20]. Some studies found livestock to become ill due to animal feed containing high concentrations of glyphosate. Also, it discovered glyphosate in meat and has postulated that glyphosate can pass the placental barrier to reach the embryos, as well as accumulate in fat tissue[28]. A study in dairy cows found that glyphosate affected the liver and muscle cells including high urea level in urine that could be due to nephrotoxicity of glyphosate[29].

Conclusion
This study demonstrated that the application of pesticides was observed to be widely applied in the agricultural sectors of Khao Koh district, Phetchabun Province. The results showed that there were glyphosate and derivatives of glyphosate (AMPA) in soil and sediment samples, while herbicides and insecticides were not found in water and agricultural samples. This environmental contamination is the major cause of health impacts for producers and consumers alike. Therefore, agriculturists should be supported by related organizations to increase organic cultivation including enhancing systems to increase organic farming networks.

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