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REPORT

STUDY ON THE CORRELATION BETWEEN SANITATION, HOUSEHOLD WATER SUPPLY, MOTHER'S HYGIENE BEHAVIORS FOR CHILDREN UNDER 5 AND THE STATUS OF CHILD NUTRITION IN VIETNAM

HANOI - 2011

FOREWORD

The great achievements of Vietnam in reducing the rate of malnutrition in children were recorded in the National Malnutrition Prevention and Control Program. In 1994, the rate of malnutrition in children under 5 accounted for 45%, and that in 2008 was reduced to 19.9%. UNICEF considered this result impressive, and Vietnam was the country in which the child malnutrition rate was reduced most rapidly in the Asian – Pacific region.

The National Strategy for Nutrition for 2001-2010 was approved with comprehensive aspects for improving child nutritional status. One of the interventions of the National Malnutrition Prevention and Control Program is to apply environmental sanitation, use clean water sources, and ensure routine de-worming, and practice hand-washing before eating, after urinating and defecating. However, up to present, the studies on the relation between the malnutrition of children under 5 and environmental sanitation, clean water sources, and knowledge and practice of mothers on personal hygiene have been insufficient in both quantity and quality. Even in the 2010 General Nutrition Survey, the focus was to study the relation between the factors of breast-feeding, feeding children and the malnutrition of children. The relation between the situation of daily-living water supply, household latrines, KAP on personal hygiene of mothers and the malnutrition of children was not mentioned. Therefore, this study was selected by UNICEF and MOH.

The Ministry of Health in cooperation with the National Institute of Nutrition and the Center for Water Supply and Hygiene Reference undertook the study on the correlation between household environmental sanitation, household water supply, and mothers' hygiene behaviors for children under 5 and the status of child nutrition in Viet Nam. The Child Survival and Development Program of UNICEF provided technical and financial support to the study. The study design and report were approved by a MOH's scientific committee on January 20 of 2011. The objectives of this study are as follows:

Describe the situation of sanitation, household water supply, and mothers or main caregivers' hygiene behaviors for the care of children under 5;

Determine the rate of malnutrition of children under 5

Determine the correlation between household environmental sanitation, household water supply, and mothers' hygiene behaviors for the care of children under 5

Recommend future relevant investments in WASH by linking with nutrition interventions

This study is based on a sub-set of samples of the 2010 General Nutrition Survey consisting of 3,356 children of 2,869 households and their mothers/caregivers, drawn from the 6

provinces of Dien Bien, Ha Nam, Ha Tinh, Ninh Thuan, Kon Tum and An Giang, which represent the 6 ecological regions of Viet Nam. The study applied the multi-variable and single-variable logistic regression models to determine the relation between household environmental sanitation, household water supply and mothers' hygiene behaviors for child care.

On behalf of all people who were involved in this study, the Viet Nam Health Environment Management Agency, MOH expresses it great attitude to UNICEF, the Center of Preventive Medicine of provinces of Dien Bien, Nam Dinh, Ha Tinh, Ninh Thuan, Kon Tum, An Giang, Nha Trang Pasteur Institute, Ho Chi Minh Pasteur institute, Central Highland Institute of Hygiene and Epidemiology and Ho Chi Minh Institute of Hygiene and Public Health for their support and cooperation.

ABBREVIATIONS

CHC	Commune Health Center
CI	Confidence Interval
CWSSR	Center for Water Supply and Hygiene Reference
GEE	Generalized Estimation Equations
IEC	Information, Education, Communication
MOH	Ministry of Health
O & M	Operation and Maintenance
OR	Odds Ratio
PAR	Population Attributable Risk
PEM	Protein-Energy Malnutrition
RWSS	Rural Water Supply and Sanitation
SD	Standard Deviation
UNICEF	United Nations Children's Fund
VHW	Village Health Worker
VIHEMA	Health Environment Management Agency of Vietnam
VND	Vietnam Dong
WHO	World Health Organization

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EXECUTIVE SUMMARY

This study was developed, following a sampled number of children among all children, who were measured in the 2010 General Nutrition Survey and exploring their household environmental sanitation and their mothers/caregivers' hygiene practices. Specifically, it studied the situation of household environmental sanitation, household water supply and mothers' hygiene behaviors for the care of 3,356 children under 5 years old in 72 communes of the 6 provinces of Nam Dinh, Dien Bien, Ha Tinh, Kon Tum, Ninh Thuan and An Giang. The study applied the multi-variable and single-variable logistic regression models to determine the relations between household environmental sanitation, household water supply and mothers' hygiene behaviors for child care and children's nutritional status.

Findings from the study:

- In the six provinces, the child stunting rate was 35.4%, and the under-weight malnutrition rate was 21.3%, a little higher than the nationwide rates (31.9% and 18.9%, respectively).

- 84.9% of the studied households had main water sources considered hygienic by definition in the WHO-UNICEF Joint Monitoring Program (Hygienic water sources include rain water, protected dug wells, tube wells, running water and protected springs regardless all other water standard indicators. Unhygienic water sources open rivers, springs and ponds). However, only 69.6% had main water sources classified hygienic according to the sensory criteria, and only 61.3% were at low risk of contamination/pollution.

- 70.3% of the studied households had latrines; this rate is slightly lower than that in the National Baseline Survey on Environmental sanitation in rural Viet Nam conducted by jointly the Ministry of Health and UNICEF in 2006 (75%). However, the rate of households with hygienic latrines by names in this study was 42.2%, higher than that of the National Baseline Survey on Environmental sanitation in rural Viet Nam in 2006 (33%). The rate of households with hygienic latrines meeting the standards of construction, operation and maintenance, which are defined in the Decision 08/2005/QD-BYT, was higher than that in the 2006 National Baseline Survey on Environmental sanitation in rural Viet Nam (30.9% vs. 18%).

- The rate of mothers regularly washing hands with soap after defecating accounted for only 36.2%, followed by washing hands with soap before eating (22.8%), before and after preparing food for children (19%), and after helping children go to stool and cleaning children's bottom (14.9%). However, the rate of mothers washing hands with soap in this study was higher than that of the National Baseline Survey on Environmental sanitation in rural Viet Nam in 2006 (before eating of 12%, after urinating of 12.2%, and after defecating

of 15.6%) and also higher than that in the observations of 390 mothers raising children under 5 in 10 communes of 5 provinces of Ha Tinh, Thanh Hoa, Ha Nam, Ha Tay and Hai Phong, conducted by the Center for Water Supply and Hygiene Reference, Thai Binh Medical University in 2007 (after defecating of 22%, after urinating of 0.8%, and after helping small children going to the toilet of 16.1%).

Results of the single-variable analysis:

- At the community level, the relation between child malnutrition and some related factors was found at various scopes. The rates of stunting and underweight malnutrition were clearly different between communes with a high rate and low rate of unhygienic latrines; between communes with a high rate and low rate of hygienic latrines; and between communes with a high rate and low rate of unhygienic water sources.

- At the household level, there were differences in child stunting and underweight malnutrition rates between families with unhygienic main water sources for cooking, drinking and other purposes and those with hygienic water sources; between families with water sources for cooking and drinking at the medium, high and very high risk of pollution and those with water sources at the low risk of pollution; between families without hygienic types of latrines and those with hygienic types of latrines; between families with hygienic types of latrines which met the MOH construction and operation and maintenance standards and those with sanitary types of latrine which did not meet the MOH standards.

- The child underweight malnutrition rate was significantly different ($p<0.05$) between the mothers who practiced and those who did not practice hand washing with soap at 5 out of 12 points of times set up in the study: before eating; before and after preparing food; after disposing and using feces; after taking care of sick people; when hands were dirty and nasty.

- The child stunting rate was obviously different depending on whether the mothers practiced or did not practice washing hands with soap before eating and when hands were dirty and with foul odors.

- Mothers/caregivers' other hygiene behaviors: the child stunting and underweight malnutrition rates were considerably higher in children whose mothers did not clean tools for feeding children, did not feed (rice, soup, porridge) in the right way after cooking, did not clean their breast before breast-feeding, did not boil water carefully for drinking of their children, did not wash hands after working in the field, did not regularly remove garbage and did not regularly clean toys for children.

Results of the multi-variable logistic regression analysis:

- The rate of underweight malnutrition at the communes with a higher rate of unhygienic

water sources for cooking, drinking and other purposes was higher than that of those with hygienic water sources; that rate in the households with latrines that did not meet the MOH standards defined in the Decision 08/2005/QD-BYT was higher than that in the households with latrines that did meet the standards; that rate in the children whose mothers did not wash hands with soap before and after preparing food was higher than that in the children whose mothers did; that rate in the children whose mothers did not clean their breast before breast-feeding was higher than that in the children whose mothers did; and that rate in the children who did not have de-worming during the last 6 months was higher than that of those who did once every 6 months.

- The rate of stunting malnutrition at the communes with a higher rate of households with unhygienic water sources was higher than that at those having a lower coverage; that rate in the households whose latrines did not meet the MOH standards defined in the Decision 08/2005/QD-BYT was higher than that in those whose latrines did; that rate in children whose mothers did not feed them immediately after cooking was higher than that in children whose mothers did.

- In the logistic regression model to analyze the child underweight malnutrition, apart from the basic variables (age, gender of the children), the variables that influenced the most on child underweight malnutrition were: no de-worming during the last 6 months; total housing area per capita less than $10m^2$; low coverage of households having hygienic water sources; mothers without washing hands with soap before and after preparing food for their children; mothers having more than 3 children; households with latrines that did not meet the MOH standards defined in the Decision 08/2005/QD-BYT; and mothers without cleaning their breast before breast-feeding.

- In the logistic regression model to analyze the stunting malnutrition, apart from the basic variables (age, gender of the children), the variables that influenced the most on child stunting malnutrition were: low coverage of households with hygienic water sources; households with latrines that did not meet the MOH standards according to the Decision 08/2005/QD-BYT; non-Kinh children; total housing area per capita less than $10m^2$; mothers having more than 3 children; and mothers who did not feed children right after cooking.

- By calculating the population attributable risk (PAR), it can be concluded with 95% confidence interval that: i) the rates of underweight and stunting among children under 5 could be reduced by 0-23% and 0-33% respectively if all households used hygienic water sources; ii) the rates of underweight and stunting among children under 5 could be reduced by 1-10% and 4-16% respectively if all households used of hygienic latrines; and iii) the rate of underweight among children under 5 could be reduced by 1-10% if all mothers/caregivers practiced hand washing with soap before and after preparing food for children.

Recommendations:

Policy:

The National Targeted Program of Rural Water Supply and Sanitation with a focus on improving environmental sanitation and water quality through better treatment/disposal of human excreta and waste should be continued. Investments should be prioritized to remote/disadvantaged areas and to the areas with low coverage of hygienic sanitation and clean water supply.

Water, sanitation and hygiene should be an integral part of any new child nutrition policy/strategy or action plans and vice versa for policy advocacy and behavioral change communication.

A comprehensive sanitation action plan with a clear road map to achieve 100% coverage of households with hygienic latrines should be developed for more effective implementation of sanitation component in the new phase of the National Targeted Program of Rural Water Supply and Sanitation.

Government should financially support very poor families with malnourished children to enable them to construct hygienic latrines for their households with particular focus on ethnic minority areas.

Policies should focus on the promotion and support to sanitation marketing for hygienic latrine construction, especially in remote areas, to meet the demand for latrines.

Intervention:

Implementation and scaling up of effective models for hygiene promotion and water quality improvement such as Community Led Total Sanitation, Intensive Sanitation Promotion, linking them with child nutrition, to rapidly and sustainably increase coverage and use of hygienic latrines, should be continued;

Sanitation marketing approach to support hygiene promotion models, which are culturally, technologically and financially appropriate to different geographic areas, should be developed; Consultation support to households on geographically and financially appropriate selection of latrine models for construction and on proper use and maintenance of the constructed latrines, should be a part of sanitation marketing.

Quality of behavioral change communication to raise community's demand for personal hygiene, household environmental sanitation, and improved water quality needs further improvements. IEC activities targeting mothers/caregivers should focus on key messages of WASH (use and protection of household water supply sources, proper use of hygienic latrines, hand-washing with soap and other child- care hygiene behaviors).

CHAPTER 1: OVERVIEW

1.1. Child Malnutrition in the world and Viet Nam

According to WHO and UNICEF [49] [52], malnutrition is caused by a lack of required nutrition or illness that affect the body's digestion. This definition is currently the most commonly used in the world and in Vietnam.

$$\text{SD score} = \frac{\text{Sized measured} - \text{Average number of reference population}}{\text{SD of reference population}}$$

Until 1981, WHO officially recommended the use of a deviation from -2SD to +2SD to classify the child nutrition status [2], with the calculation as follows:

The Classification scale is based on weight and height by the following indicators [2]:

- Age-specific weight: The children who have age-specific weight at threshold point -2SD and over are considered as normal. Children having age-specific weight at below -2SD are considered as underweight.

- Age-specific height: The children who have age-specific height at threshold point -2SD and over are considered as normal. Malnutrition based on age-specific height at below -2SD is called stunting (prolonged malnutrition); it indicates a slow growth due to nutritional condition and unreasonable health.

- Height-specific weight: The children who have height-specific weight at lower than -2SD are considered as malnourished. Malnutrition based on height-specific weight is known as wasting; it indicates a current lack of nutrition.

The above classification is very meaningful to identify whether malnutrition is caused in the short term or accumulated over the long term; therefore, the appropriate and effective interventions should be proposed.

Actual situation of child malnutrition

- In developing countries

Although there have been many positive changes in recent times, under-5 child malnutrition is still a common public health problem in developing countries [23,53]. According to WHO and UNICEF, in 2002, there were 182 million malnourished children worldwide. In the Fifth report on Global Nutrition in 2005 of the Research Institute for International Food Policy and Strategy and United Nations Standing Committee on Nutrition, there were 178 million malnourished children under 5 (32%) in developing countries [26].

Overall, malnutrition in developing countries still remains at a high level and is different among continents, areas, countries [49]. Africa and Asia are the two continents where malnutrition is quite alarming with the rate of stunting child malnutrition in 2005 at 40% (in

Africa) and 31% (in Asia) [49, 53]. From calculations for all developing countries, approximately 32% of children under 5 (178 million) were stunted, of which, the Middle Africa region (50%) and West Africa region (42%) were found to have the highest rates. With 74 million children suffering from stunting malnutrition, South-Central Asia has become the region with the highest rate of stunting malnutrition in the world. For wasting malnutrition, the rate in developing countries was 10% (55 million) and the South-Central Asian region was still found to be the highest rate (16%) and the highest number of children suffering from wasting malnutrition (29 million). The gap in economic development between regions and countries is a persuasive reason for this difference. Besides, the capacity in ensuring food security, accessibility to health services and social concern in preventing malnutrition are reasons for this situation in Africa and Asian countries [49, 53].

The rate of stunting malnutrition is on a downward trend in developing countries [52]. According to the estimate of UNICEF, this rate will decrease from 34% in 2000 to 16.3% in 2020. However, this decrease is different among regions. As estimated in Asia, Latin America and the Caribbean, both the rate and number of stunted children will reduce significantly. Whereas, in Africa, the rate of stunting malnutrition will only reduce slightly by about 4%, from 35% in 2000 to 31% in 2020. This rate includes the increasing number of children in Africa in 20 years (from 44 million in 2000 to 48 million in 2020).

- In Viet Nam

In Viet Nam, before the 1990s, severe malnutrition, such as Marasmus and Kwashiorkor, was really common in hospitals and in the community [2, 12]. In recent years, they have been rarely found. At present, mild and moderate malnutrition is common in slow growth and underweight. Together with stable economic development, Vietnam has had positive changes in malnutrition prevention and control [2,12]. The data on child nutrition status through 1999 to 2009 [25] shows the following trends:

Figure 1.1.Changes in stunting malnutrition rate in children under 5 in the whole country from 1999 to 2009

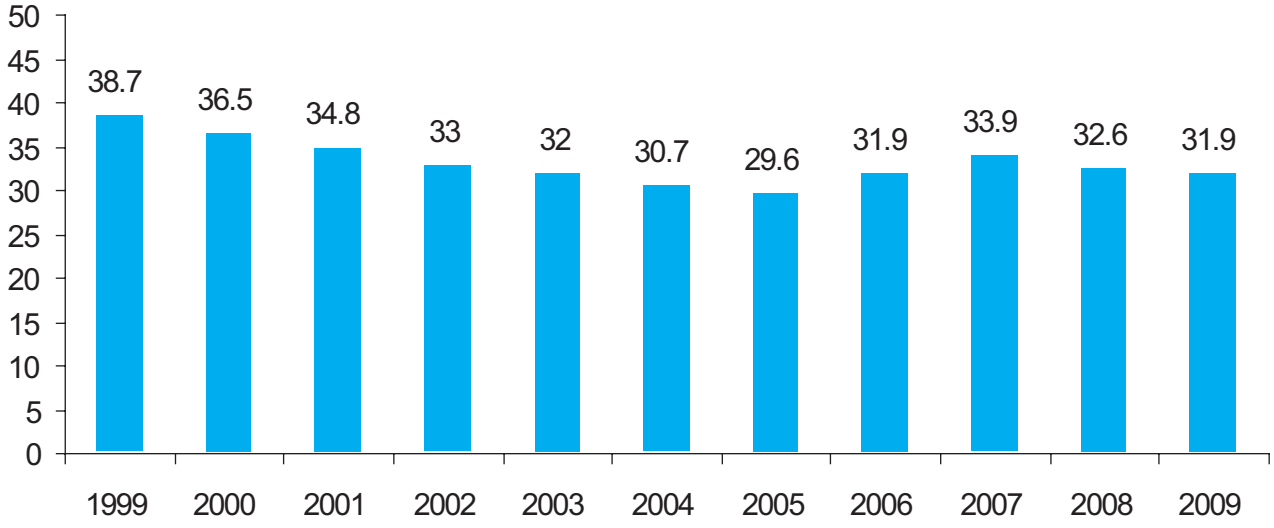
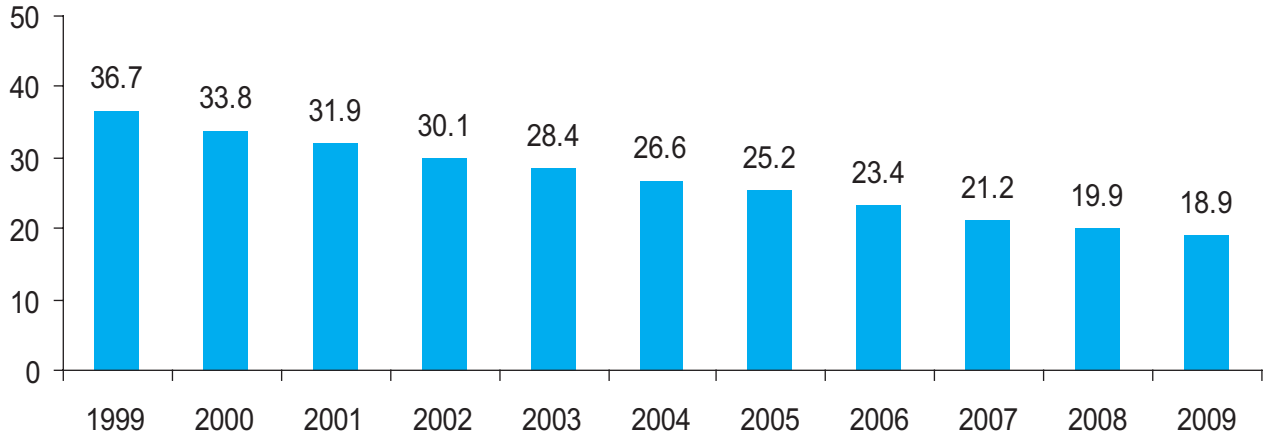


Figure 1.2. Changes in underweight malnutrition rate in children under 5 in the whole country from 1999 to 2009



In 1999, the nationwide under-weight malnutrition rate was 36.7%, and was reduced to 18.9% in 2009. However, it still remains at a very high level according to the WHO [2], [5]. Before 1995, the average reduction in stunting malnutrition was 0.6% per year. Since 1995, reduction has increased from 1.5% to 2% per year. This was a rapid reduction in comparison with the other countries in the region [2, 12]. This is an achievement of stable economic development, national and household food security as well as society's interest in malnutrition prevention and control. However, the rate of stunting malnutrition reduced slowly, from 38.7% in 1999 to 31.9% in 2009.

1.2. Environmental sanitation, water supply and mother's hygiene behavior for child care

Water supply and environmental sanitation

In the Asia-Pacific region, 830 million people in developing countries do not have enough clean water.

According to WHO, the rate of people who can access hygienic latrines in urban and rural areas was different among countries. In Thailand, nearly 100% of the population can access hygienic latrines. In Indonesia, the rate of urban population who can access hygienic latrines was 64%; this rate in the rural population was 42%. In Cambodia, 62% of the urban population can access hygienic latrines while only 10% of the rural population can do so[56].

Up to now, globally 2.6 billion people still can't have access to a single improved latrine. Most of them are living in developing countries, accounting for 50% of the total population of the developing world. The latrine coverage was found to be the lowest in Sub-Saharan Africa (36%) and South Asia (37%). In some countries such as Afghanistan and Ethiopia, less than 10% of the population can access standard sanitation facilities [16].

In Vietnam, more than 80% of diseases are related to water sources, mainly diarrhea, typhoid, parasites and hepatitis. The main cause is contamination from organisms and microorganisms, which directly affects people's health, especially the elderly and children [1].

Besides environmental sanitation, water supply also plays an important role in human life. In the Global Summit Conference on Sustainable Development in Johannesburg, South Africa in August 2002, the president of the International Water Association warned that of the 6 billion people on our planet, 1.2 billion were lacking clean water, 2.6 billion were living in unsafe hygiene conditions and about 2.2 million deaths each year in the developing countries were related to water supply and hygiene conditions [15,16].

In Vietnam, according to the 2002 National Health Survey, approximately 50% of households did not have latrines. Most of these household members practiced open defecation or had to share latrines with others. Among 50% of households with latrines, most had single-vault or bucket latrines and used feces for fertilization. The other common latrines were double-vault latrines in the North and fish pond hanging latrines in the South, which accounted for 10%. The remaining ones used pour-flush latrines and septic tank latrines. Only 20% of latrines were hygienic [6]. This figure was improved over time and by 2006, a national survey on environmental sanitation reported that 33% of households in rural Vietnam had hygienic latrines [8].

The National Health Survey conducted by MOH in combination with the General Statistics Department on 36,000 households in 1,200 communes on the 25th September, 2003, showed that the rate of households using running water only accounted for 15.7% [7]. According to the National Health Survey [6], in rural areas, the dug well was the most common water source. Up to 44% of the rural population had large dug wells. Moreover, on average, up to 22% of households used unsafe surface water sources for daily different purposes.

The overall objective of the National strategy on rural water supply and rural sanitation approved by the government until 2020 is that all rural populations will have access to hygienic latrines via strengthening the participation of inhabitants; the approaching method will be based on their demand; all rural population will have hygienic behavior; and environmental sanitation at villages, communes, and community's practice on environmental sanitation will be improved [15].

Solving the problem of water supply and environmental sanitation in urban as well as rural areas will limit environmental pollution, reduce morbidity and eliminate some diseases that have existed for many years such as diarrhea, typhoid, dysentery, parasite infection, etc. The aim is to enhance step by step the community health status and improve the living environment.

Hygiene behaviors on child care

Child health depends much on parents' care behaviors, especially in children under 5, who cannot conduct personal hygiene practices or eat and drink independently. Besides an appropriate nutrition routine, mothers/care givers' child care behaviors such as washing hands before breastfeeding, before preparing foods, and de-worming for children… also considerably contribute to child malnutrition control.

The rate of the population regularly washing hands with soap is very high in the developed countries. In August 2005, an observation study on hand washing with soap of 6,336 persons at some public toilets in 4 big cities in the USA showed that the rate of washing hands with soap after using public toilets was 83%, higher in women (90%) and lower in men (75%) . The rate of the population regularly washing hands with soap was very low in developing countries. In Ghana, an observation study reports that only 4% washed hands with soap [36].

A baseline survey (before intervention) on the "Actual situation of washing hands with soap supported by the Unilever fund" at 10 communes in Ha Tinh, Thanh Hoa, Ha Nam, Ha Tay and Hai Phong from December 2006 to January 2007 [8] showed that the rate of the population washing hands with soap was very low. Only 6.1% washed hands with soap before eating, 0.8% after urinating and 14.6% after defecating. The rate of mothers washing hands with soap before feeding children, after cleaning children's bottom and after treating their feces was also very low (2.6%, 10.5% and 16.1% respectively).

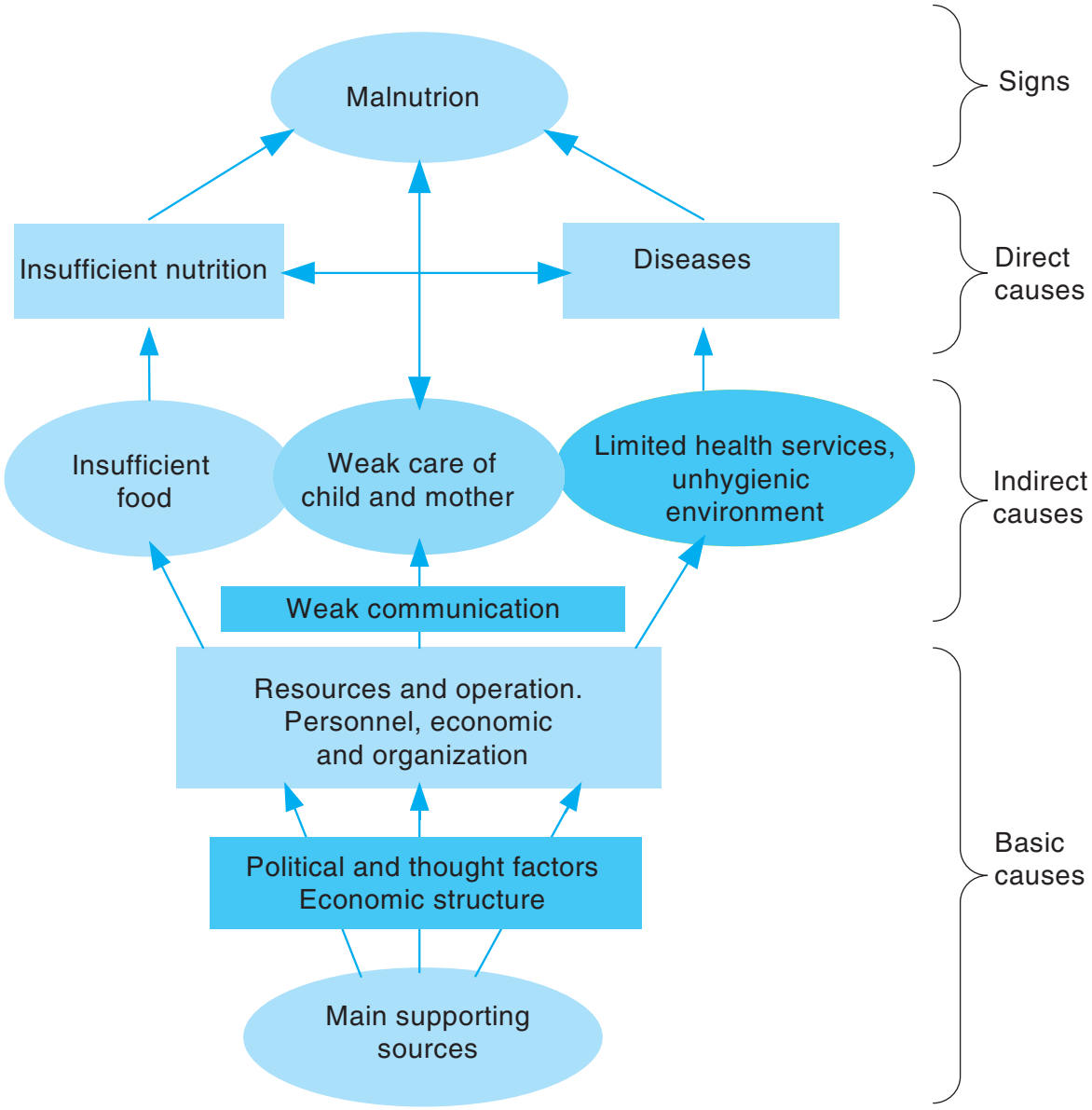
According to the General Department of Preventive Medicine and Environmental Health, the rate of mothers washing hands with soap/washing liquids at some important points was still limited: 15.3% before eating, 4.7% after urinating, 25% after defecating, 13.2% beforefeeding children, 25% after cleaning children's bottom and 29.3% after handling their feces [10].

In the world, about one billion people were infected with worms, in which 69.5% of those were children under 15. In China, 358 million persons were infected with worms, 37.8% of them were children under 5. In India, 319 million persons were infected with worms, 42.1% of them were children under 5. In Vietnam, inhabitants have not had a habit of washing hands after using toilets (over 82%), they still use untreated feces for growing vegetables; thus, the rate of children infected with worms is very high, about 80% (especially in rural children). As estimated, up to 44% of Vietnamese children are infected with threadworm, hookworm and ascarid. This is also a reason why Vietnam is still a country with the highest rate of child malnutrition in East Asia [18]. The rate of worm infection in children was different by region and socio-economic development. The rate of worm infection in children under 15 in developed countries was 10%, while it was found to be up to 90% in developing countries.

1.3. Relation between environmental sanitation, household water supply, and mother's hygiene behavior

Causes of child malnutrition are described as follows:

Diagram 1.1: Causes of child malnutrition [2]:



- *Direct causes:* unhealthy diet and diseases, especially infectious diseases.

- *Indirect causes:* weak food security, inadequacies in maternal and child care, problems in health services and poor environmental sanitation (water, air, house, and waste management).

- *Fundamental causes (root causes):* poverty and under development, including economic inequality.

The above model shows that diseases are causes of malnutrition in children. Among child diseases, diarrhea was the second leading cause of mortality of children under 5, and was a main and direct cause of child malnutrition. Diarrhea usually leads to dehydration, even when children are treated with salt water to compensate electrolyte, they are still quickly malnourished after diarrhea. On the other hand, if diarrhea is stopped, the risk of child malnutrition would be indirectly reduced. In addition, many other diseases also affected the nutrition of children such as parasite infection, bronchitis, etc.

Recommended by UNICEF and the WHO, a strategy to prevent child malnutrition is the reduction of diarrhea in children. Through a re-analysis of 2120 articles from 46 different studies around the world, Fewtrell asserted that the rate of diarrhea will decrease to 44% by washing hands with soap; 39% by treatment of water before use; 32% by improved environmental sanitation; 28% by increased awareness of hygiene; 25% by protection of water sources; and 11% by use of clean water [35].

Besides the environmental factors, the nutrition status of children also affects the rate of diarrhea. Lopez-Alarcon asserted that breastfeeding children aged less than 6 months old reduced the frequency and duration of pneumonia and diarrhea [43]. A study by Barreto (Brazil) in 1994 shows that if young children get sufficient Vitamin A, the rate of diarrhea will decrease (RR=0.8, 95% CI: 0.65:0.98), even lower in children suffering from serious diarrhea (> 6 times of defecation per day) [27]. Gerald reported that recent studies showed the existence of the relation between malnutrition and deficiencies of micronutrients, especially Vitamin A, Zinc and Iron. The lack of these nutrients might influence the immune function of the body. It indicated that a malnourished child is susceptible to infectious diseases such as pneumonia and diarrhea. When children are suffering from bacterial infections, their malnutrition status would be worse[35].

The International Food Policy Research Institute (IFPRI) described factors related to fundamental and potential causes of malnutrition and shows that the malnutrition rate would be reduced by 1% if an added 13.1% of the population can access clean water [52].

Some recent literature reviews show 36 countries which implemented the malnutrition intervention on hand-washing and environmental/personal hygiene. The combination of improved nutrition and reduced communicable diseases reduced the rate of wasting and stunting malnutrition in children by 36% [52].

In the Philippines, North Korea and Cameroon [29,38,44], in addition to ensuring national food security, the improvement of environmental sanitation and water supply was paid attention to. In 2002, the Oil-for-Food Program (OFFP) and Targeted Nutrition Program (TNP) in Iraq [49] reduced the rate of wasting and stunting malnutrition in children to 30% through the better use of food, clean water, health facilities and breastfeeding.

The Malnutrition Prevention Program in India [48] supported by UNICEF was the largest nutrition intervention program in this country. The program covered all aspects of malnutrition prevention with the aim to improve environment and water hygiene, public education and women's knowledge and health.

An overview on child nutrition in the developing countries conducted by Haaga J shows a close relation between the malnutrition in children and clean water supply. The malnutrition rate in children will be high if many people lack clean water. This finding was also proved in a study by the World Bank (WB) on the relation between nutrition and hygienic water, latrines and personal hygiene in Ethiopia [442].

In Viet Nam:

In general, studies on the relation between environment, water, personal hygiene and nutritional status of children under 5 in Vietnam have been very limited in both quantity and quality, while programs and research on child malnutrition have been conducted fairly completely.

The outstanding achievements in reducing child malnutrition were recorded in the National Malnutrition Prevention Program initiated in 1994. The rate of malnutrition in children under 5 decreased from 45% in 1994 to 26.6% in 2004, and about 18.9% in 2009. From 1995 onward, the average reduction of child malnutrition rate was 0.6% per year. Since that time, the reduction has been 1.5 to 2% per year [2, 3, 5]. This result was impressive to UNICEF and Vietnam became the only country showing a rapid reduction of child malnutrition among the Asia-Pacific countries. The National strategy on nutrition in the 2001-2010 period [4] was approved. One of the interventions of malnutrition prevention in children is to ensure environmental sanitation, use of clean water, de-worm frequently, and wash hands before eating and after defecating and urinating.

In Vietnam, studies on the relation between environmental sanitation, clean water use, knowledge and practice of main caregivers for child care and under-5 child nutrition have been limited. However, there has been some research on under-5 child malnutrition mentioning the relation between child malnutrition and hygiene. The study of Pham Gia Lai conducted in Thai Binh [13] pointed out a lack of hygienic latrines at households caused a higher risk of child malnutrition ($p<0.05$). A study conducted by Dinh Dao and Dinh Thanh Hue on the nutrition of children under 5 from ethnic minorities in Quang Nam shows the same result [14]. In the assessment report on activities and efficiencies of malnutrition prevention projects in the period 1999-2004 [20], Nguyen Cong Khan reported the relation of the environment sanitation and water quality to the malnutrition rate in children. Thus, if household have access to clean water and hygienic latrines, their children would be less likely to be malnourished.

2010 General Nutrition Survey conducted by the National Institute of Nutrition was mainly designed to identify factors such as breastfeeding and infant/child feeding related to child nutrition. However, the relation between environmental sanitation, water source, mothers' behavior for child care and child nutrition was not considered. The current question of concern is how sanitation, water supply, and personal hygiene of mothers influence under-5 child nutritional status.

From data source of the 2010 General Nutrition Survey, An additional study on environmental sanitation, water source, and the child care behavior of the mothers of the families whose children were selected to the anthropometry component of the General Survey will be conducted to answer the research question.

To find scientific evidences to convince the government to invest more on sanitation and water quality integrated into nutrition interventions, UNICEF supported this study to determine the above relation. If the relation between sanitation, water quality and hygiene behavior of mothers for child care and child nutrition is confirmed in the study, it will help MOH and UNICEF continue to strengthen activities on environmental sanitation and nutrition in the "Child Survival and Development" program. The study will also recommend more effective investments on nutrition, sanitation, water quality and personal hygiene.

CHAPTER 2: METHODOLOGY

2.1. Study design

This is a descriptive cross-sectional survey, combining both qualitative and quantitative methods.

This study referred to the result of the anthropometric part of 2010 General Nutrition Survey. All the households having children selected to investigate their malnutrition status were chosen to investigate the condition of water sources, household latrines, and the personal hygiene of mothers/caregivers when taking care of their children under 5.

After that, the relation between water sources, household latrines, mothers' personal hygiene and the rate under-5 child malnutrition were analyzed.

2.2. Study subjects

- Children under 5 (in the list of the 2010 General Nutrition Survey conducted by the National Institute of Nutrition at the selected provinces whose mothers agreed to allow them to participate in the study)

- Their mothers (or caregivers) (who agreed to participate in the study and have been living in the studied sites for at least one year)

- Their houses, daily water sources, latrines - Health workers of their communes (Heads of CHC, VHWs, and nutritional collaborators)

2.3. Study time

Duration of data collection in the field: From 1 of November to 25 of December, 2009

2.4. Studied sites

The study team chose 6 provinces in 6 ecological regions of Viet Nam as follows:

Northern mountainous region:	Dien Bien province
Red River Delta:	Nam Dinh province
Northern Central Coast:	Ha Tinh province
Southern Central Coast:	Ninh Thuan province
Central Highlands:	Kon Tum province
Mekong River Delta:	An Giang province.

Among the 6 studied provinces, 4 provinces were the project interventional sites of UNICEF, including: Dien Bien, Ninh Thuan, Kon Tum and An Giang.

2.5. Sample size and sampling

2.5.1. Foundation for sample size and sampling

Children in the list of the 30 clusters used in the 2010 General nutrition survey conducted by the National Institute of Nutrition were referred to for sampling in this study. The sample size was recalculated according to the hypotheses of the relation between household environmental sanitation (environmental sanitation, household water supply or mothers' hygiene behavior for child care) and child malnutrition. They are:

Hypothesis 1: The malnutrition rate (age-specific weight) of children aged 0-23 and 24-59 months in the households with poor water sources and unimproved sanitation facilities is 7% higher than that of those in households with improved water sources and improved sanitation facilities.

Hypothesis 2: The under-5 child malnutrition rate (age-specific height) of children in households with poor water sources and unimproved sanitation facilities is 7% higher than that of those in households with improved water sources and improved sanitation facilities.

2.5.2. Sample size

The sample size was calculated based on the hypotheses H_0: $\pi_{0=}\pi_1$

The formula was adjusted according to the clusters sampling method of Hseih F.Y. [38]:

In wich:

$$n = \left(Z_{\alpha/2} + Z_{\beta}\right)^2 \frac{[p_0(1-p_0)+p_1(1-p_1)][1+(m-1)r]}{(p_0-p_1)^2}$$

- *n*: (sample size): the number of surveyed children (the number of mothers and households is equal to this number of surveyed children).
- $Z_{\alpha/2}$ = 1.96: the error probability type I used for two-dimensional comparison with reliability of 95% (α = 5%).
- Z_{β}= 0.84: the probability with effect of the sample = 80% (or error probability type II β=20%)
- p_0: the under-5 child malnutrition rate (age-specific weight) in households with improved environmental sanitation. It was supposed to reduce by 7% in comparison with that of households with unimproved sanitation facilities.
- p_1: the under-5 child malnutrition rate (age-specific weight) in households without improved sanitation facilities. The rate of child malnutrition was supposed to be equivalent to that rate in the 6 provinces of the Nutrition Survey in 2008.

- $1 + (m - 1)\ \rho = 3$: the adjusting coefficient of cluster sampling (Design effect), where:
- $m = 51$: the initial cluster sample size (total number of children selected in a cluster (commune) of the Annual Survey conducted by the National Institute of Nutrition in 2008)
- $r = 0.05$: the Intra Cluster Relation (= Within-cluster Variance/between cluster Variance). r was calculated according to the Annual Survey conducted by the National Institute of Nutrition in 2008.

The sample size was calculated according to the age-specific weight of the 2 age groups: 0-23 months and 24-59 months. Outputs were calculated from the malnutrition rate by age-specific weight and age-specific height in the Survey in 2008 of the 6 provinces where the 2 groups above were selected. It is assumed that the malnutrition rate reduced 7% and the proportion of children under 2 years old (0-23 months) accounts for 42.23% of the total number of children under 5 according to the results of the 2010 General Nutrition Survey. Thus, the adjusted sample size was 3,356 children. From those children surveyed on anthropometric nutrition, we determined their households to assess the water supply, hygienic latrines, and mothers' hygiene behaviors. Sample sizes of the 6 provinces are presented in the table below:

Province	No. of children	No. of households
Nam Dinh	552	489
Dien Bien	594	494
Ha Tinh	555	506
Kon Tum	532	403
Ninh Thuan	580	482
An Giang	543	495
Total	**3,356**	**2,869**

2.5.3. Sampling

Six provinces representing 6 ecological regions were selected intentionally; they are: Dien Bien, Nam Dinh, Ha Tinh, Ninh Thuan, Kon Tum, An Giang.

The next steps of sampling were referred to the Annual Survey on Nutrition conducted by the Institute of Nutrition. The sampling applied the multi-level method:

Level 1 - commune: Selected 30 communes from the list of each province by applying the Probability Proportional to Size method (PPS).

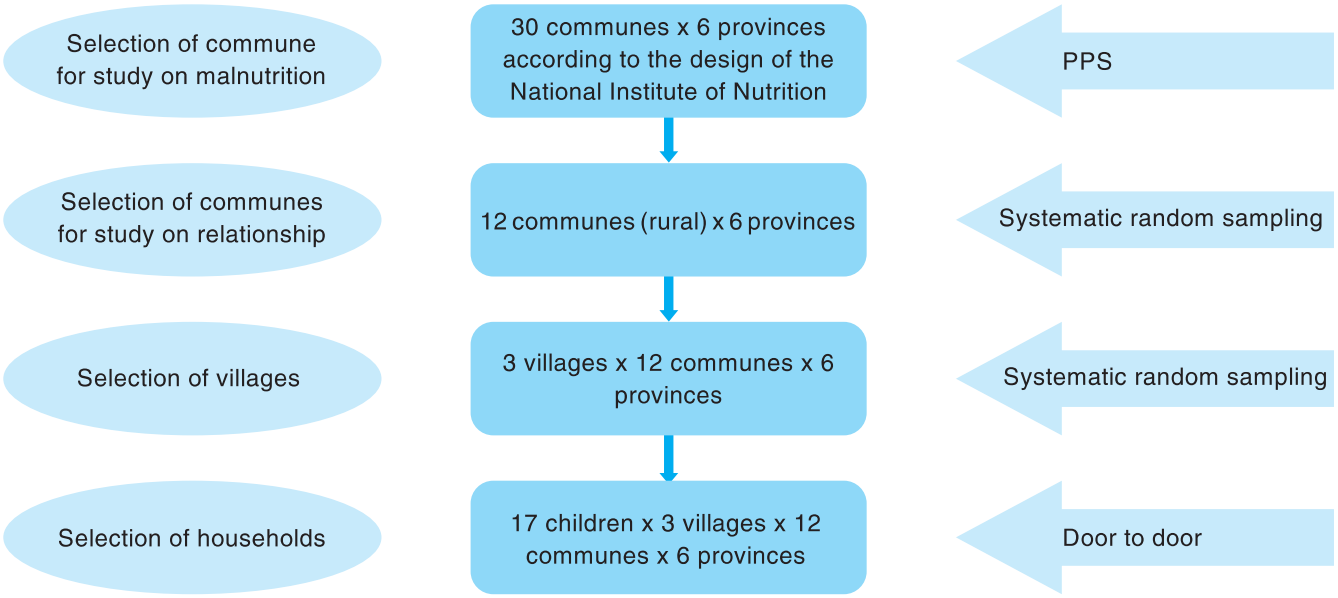
Level 2 - sites of national census (villages) in the selected communes: Selected 3 representative sites by applying the systematic random sampling method.

Level 3 - individuals: Selected 17 children under 5 and their mothers by applying the method for finding households as applied in the survey on the immunization program. Thus, 51 children were selected from each commune.

Selection of communes: Each studied province selected 12 communes out of the 30 communes previously selected in the 2010 General Nutrition Survey. These communes were all located in rural areas In In total, 72 communes were selected; the list of communes is presented in the annex.

Selection of households: Houses of children selected in the survey on anthropometric nutrition were evaluated to determine the water sources, hygienic latrines, and mothers' hygiene behaviors..

Diagram 2.1 of sampling



2.5.4. Sample size for in-depth interview

In each province, one commune was randomly selected for in-depth interviews, making a total of 6 communes. At each commune, in-depth interviews were conducted with the head of Commune Health Center (CHC), health staff involving in the malnutrition prevention program, one village health worker, one mother having children aged under 12 months, one mother having children aged 12-35 months and one mother having children aged 36-59 months. The sample size for in-depth interviews was 36.

2.6. Data collection

- At the selected households, investigations of the water sources, latrines, availability of soap for hand-washing were conducted by observations and filling in the observation checklist.

- Structured survey tools were used to investigate the hygiene behaviors of the mothers with children under 5.

- In-depth interviews were conducted with the mothers with children under 5 and medical staff, using the in-depth interview guidelines.

- Secondary data was collected on natural conditions, population, socioeconomics, sanitation facilities, and nutrition status at each commune by using the data collection forms.

Data collection tools:

- Forms to collect secondary data at each commune.

- Checklists to evaluate water sources, latrines, soap for hand-washing (observations in combination with interviews).

- Forms to evaluate the knowledge, attitude and behavior of the mothers about water sources, sanitation and hygiene related to children under 5.

- Guidelines for in-depth interviews with the mothers with children under 23 months old.

- Guidelines for in-depth interviews with the mothers with children from 24 to 59 months old.

- Guidelines for in-depth interviews with health staff.

2.7. Evaluation criteria

- Malnutrition by age-specific weight (under-weight): Weight of children was compared to that of the WHO reference population by gender and age. Children are considered malnourished if the z-score of their age- specific weight is lower than -2SD.

- Malnutrition by age-specific height (stunting): Height of children was compared to that of the WHO reference population by gender and age. Children are considered malnourished if the z-score of their age- specific height is lower than -2SD.

- Households with clean water sources: Households with tap-water, rain water, dug wells, drilled wells, spring water that was clean by sensory criteria (clear, colorless, odorless, tasteless), were considered at low risk of pollution.

- Risk levels of water pollution were determined using the WHO scale for risks of water pollution.

- Hygienic latrines were determined by the MOH standards specified in its Decision No. 08-2005/QD-BYT.

- Relationship between household water sources, household latrines, mothers/care givers' hygiene behaviors, and under 5 child nutritional status was determined by odd ratio (OR) calculation.

To determine the coverage and hygienic standards of latrines in rural areas, five following main indicators were selected:

-The rate of households with latrines: To calculate this rate, the number of households having latrines was divided by the total number of the surveyed households, and then multiplied by 100. This rate is used to determine the rate of households with latrines regardless of the types of latrines and its hygienic standards. At the same time, it indirectly reflects the community's capacity of human feces management.

-The rate of households with hygienic types of latrines: this rate is calculated by dividing the number of households with hygienic types of latrines by names (septic tank, pour-flush, double-vault, ventilated pit and Biogas) by the total number of surveyed households and then multiplying by 100. It is used to determine the rate of households with hygienic types of latrines. However, this rate does not reflect whether the latrines meet construction standards and operation and maintenance standards specified in the MOH Decision 08/2005/QD-BYT. This rate also helps us to calculate the rate of rural households that need to construct new latrines, including the households with no latrines and with latrines which did not belong to the five types named above. This rate, moreover, will be used to compare with the rate of hygienic latrines from the previous surveys because all of these surveys counted the hygienic types of latrines only and did not assess construction standards and operation and maintenance standards.

-The rate of households with latrines meeting the construction standards: to calculate this rate, the number of the households with hygienic types of latrines by names, that met all construction standards defined in the MOH Decision 08/2005 QD-BYT was divided by the total number of the surveyed households and then multiplied by 100. This rate is used to determine the rate of hygienic types of latrines meeting construction standards. It also indicates the rate of latrines in use which do not need to be newly constructed. This rate and the rate of households with hygienic types of latrines are used to estimate the number of latrines in need of construction improvement and repair so as to meet construction standards.

-The rate of hygienic types of latrines by names meeting the standards of operation and maintenance: This rate is calculated by dividing the number of households with hygienic types of latrines that met all operation and maintenance standards outlined in the MOH Decision 08/2005/QD-BYT by the total number of surveyed households, and then multiplying by 100. It is used to assess how operation and maintenance of latrines was in

the community. In addition, it indirectly evaluates the need of education and communication in order to raise awareness of and to change people's behavior toward proper operating and maintaining latrines.

-The rate of hygienic types of latrines that met both construction and operation & maintenance standards: To calculate, the number of households having hygienic types of latrines that met both construction standards and operation & maintenance standards mentioned in the MOH Decision 08/2005/QD-BYT is divided by the total number of surveyed households, and then multiplied by 100. This rate is used to determine the rate of hygienic latrines. It also refers to the rate of rural households that apply correct practices of collecting and treating human feces regulated by MOH.

2.8. Bias control

This is a descriptive study with strict sample sizes and sampling; it also combined both quantitative and qualitative methods. The survey forms were designed clearly with comments of experts on environmental sanitation, clean water, nutrition and statistics. The forms were pre-tested before formal implementation. The surveyors were those who had good experience and were trained in data collection.

The data was strictly monitored and supervised. 100% of the survey forms were checked by supervisors; 5% of were re-interviewed about basic information.

Data cleaning and entering were strictly monitored and supervised. An error- checking program was used to correct errors of data inputs.

The complex sample analyzing method for a survey with sampling in stratifications and clusters using weights was applied to adjust the result.

2.9. Data processing

Quantitative data was carefully checked before inputs using the Epi DATA software. The data was processed by using the SPSS software - version 15.0. The results were presented in 2 parts:

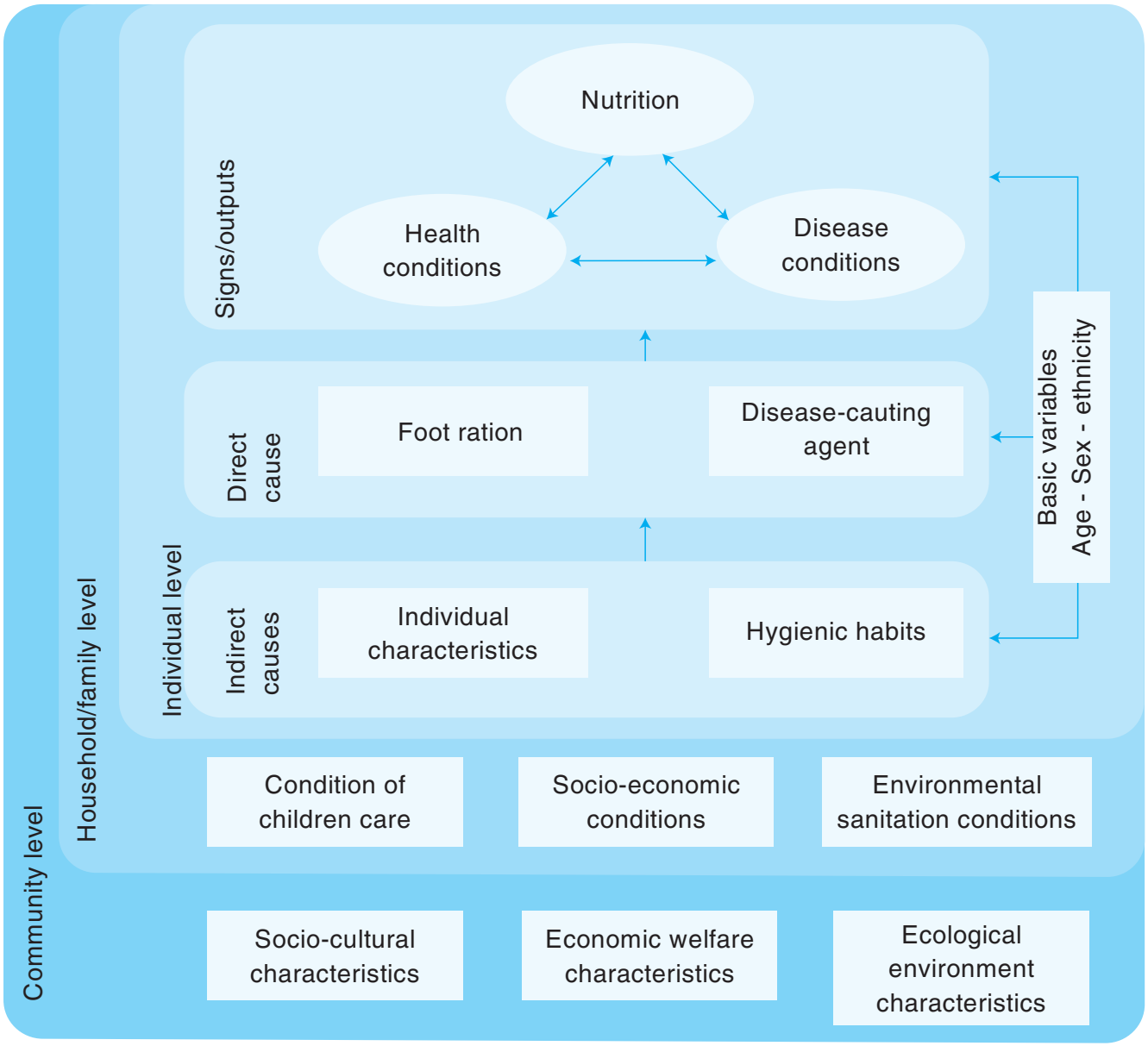
Description: to present the frequency of variables and average values of continuous variables.

Single-variable analysis: The Chi-square test (÷2) was used to analyze the relation and the odds ratio (OR was calculated to determine the relation strength. The study hypothesis was tested by comparing 2 groups, for example, the comparison of the malnutrition rate of children in households with improved sanitation facilities and that of those in households with unimproved sanitation facilities after adjusting the standard errors according to their weights, cluster and strata.

Multi-variable analysis: Based on the results from single-variable analysis, the variables with strong relation with child malnutrition were put into the multi-level and multi-variable logistic regression models to control bias. The multi-level analysis was used to identify the maximum number of factors that influenced child nutrition. This model had 3 analytical levels: 1) individual; 2) household; and 3) commune (community). This model was widely applied in many studies with a) multi-level data structure; b) cohort study with evaluation at many points of time; c) time events model. With this model, the output indicators may be the nutritional status, disease, health or behavioral health of the subjects; these were put into the individual level (1st level); because study subjects may live in the same house, have the same mother, and share food, utensils, water sources and latrines, they were put into the household level (2nd level); because the households are in the same community such as villages, communes... they were put into the community level (3rd level) which is impacted by the same ecological environment (air, water source...), public environment (road, health facilities, market, information sources such as loudspeakers, oral communication, posters in public places...).

The multi-level analysis model was used in the form of logistic regression analysis when variables have unclear relation. This allows a simultaneous test of the effects of variables at multiple levels: from individual to community levels, while independent variables are not ignored. This is also to simultaneously test the deviation between groups and within each group; to test the deviation between levels and within each level. The multi-level analysis method is presented in detail by Roux [48].

Diagram 2.2.: The multi-level logistic regression analysis model of relation between malnutrition and risk factors



In-depth interviews were processed by transcription to be analyzed according to the topics to prove quantitative results, and provide comments, remarks.

2.10. Study implementation

Investigators were experienced persons of the Research Center for Water Supply and Environmental Sanitation Reference, Thai Binh Medical University. They have participated in many environmental sanitation studies and have deep understanding of the health system in Vietnam.

All investigators and supervisors were trained in Hanoi for 3 days and spent 2 days for the

pre-testing survey in Ha Nam. The total selected staff for training was 20 persons including 4 supervisors and 16 investigators.

Two field work groups were organized. Each group included 2 supervisors and 8 investigators to survey in 3 provinces: Group 1 in Dien Bien, Nam Dinh, Ha Tinh, and Group 2 in Kon Tum, Ninh Thuan and An Giang.

Data processing was done immediately after field work. The data processing and analyzing group consisted of 3 experts (one statistician of epidemiology and 2 data analysts and 10 persons for entering the data. Report writing was conducted immediately after data analysis.

2.11. Study limitation

The water sources used for drinking and cooking of the studied households were not tested and analyzed against any of the 22 indicators stated in the MOH decision 09/2005/QD-BYT due to large sample size, large survey sites, and limited time and budget. However, risk factors of water contamination were observed. The observation of personal hygiene behaviors of mothers was not performed; direct interviews were used instead due to the large sample size, large survey site, and limited time and budget.

This is a cross-sectional study, so it could determine the correlation only, not the causes.

2.12. Study ethics

The study was conducted after the study proposal was approved by the MOH Ministerial Science Committee. All the children's households agreed to participate in the study. Personal information was guaranteed to be confidential. Study results were fed back to the localities. The mothers were informed about their unhygienic water sources and unhygienic latrines and its bad effects on health status , poor knowledge, poor hygiene practices on child care if it is the case . If the children got diarrhea, their mother received Oresol or was instructed on how to make glucose-salt solution. The field work was approved by the functional and local authorities, and the results were sent to them.

CHAPTER 3: RESULTS AND DISCUSSION

3.1. Epidemiology of the nutritional status of under-5 children

In 2010, the Ministry of Health, the National Institute of Nutrition and UNICEF jointly conducted a study on the correlation between household environmental sanitation, household water supply, and mothers' hygiene behaviors for children under 5 and the status of child nutrition in Viet Nam. This study is based on a sub-set of samples of the 2010 General Nutrition Survey consisting of 3,356 children of 2,869 households and their mothers/caregivers, drawn from the 6 provinces of Dien Bien, Nam Dinh, Ha Tinh, Ninh Thuan, Kon Tum and An Giang, which represent the 6 ecological regions of Viet Nam. The study applied the multi-variable and single-variable logistic regression models to determine the relation between household environmental sanitation, household water supply, mothers' hygiene behaviors for child care and children's nutritional status.

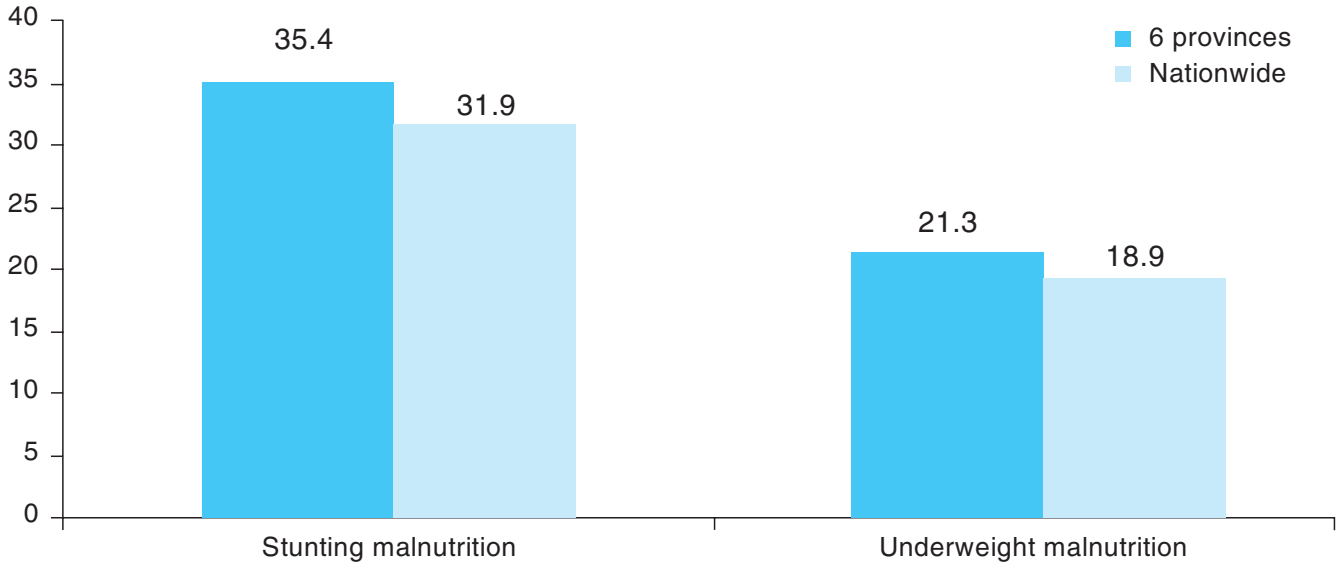
Table 3.1. The malnutrition status in 6 provinces

Province	Stunting malnutrition		Underweight malnutrition	
	n	%	n	%
Nam Dinh (n=552)	131	23.7	82	14.9
Dien Bien (n=594)	230	38.7	121	20.4
Ha Tinh (n=555)	212	38.2	135	24.3
Kon Tum (n=532)	247	46.4	148	27.8
Ninh Thuan(n=580)	209	36.0	127	21.9
An Giang (n=543)	160	29.5	101	18.6
Total (n=3356)	**1189**	**35.4**	**714**	**21.3**

The rate of stunting malnutrition in children under 5 in the 6 survey provinces was 35.4%, higher than that of underweight malnutrition (21.3%). This high rate of stunting malnutrition reflects that the stunting growth was caused by the deprivation of nutrients and prolonged diseases.

The comparison between the rates of malnutrition in this study and those from the 2010 General Nutrition Survey is presented in the figure 3.1. [24].

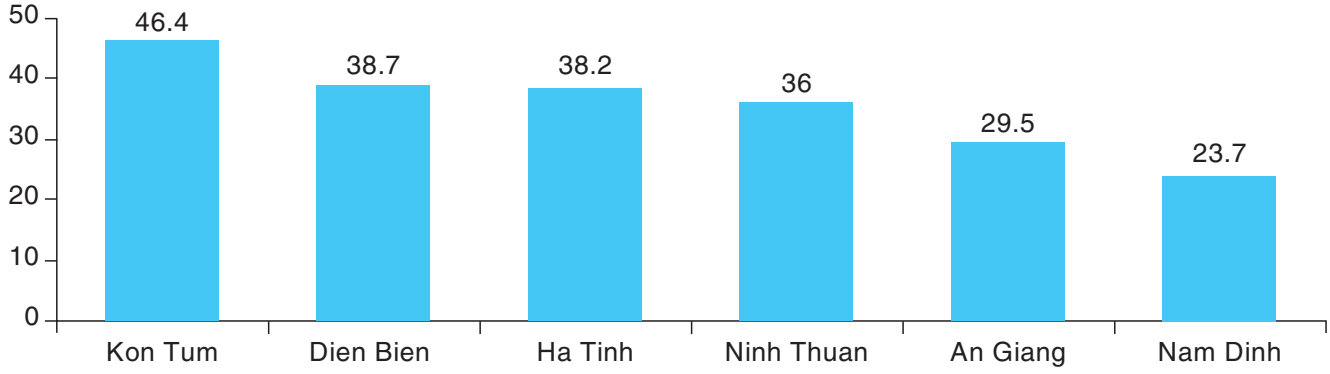
Figure 3. 1. The rate of child malnutrition in 6 provinces in comparison with those in the 2010 General Nutrition Survey



The rates of stunting and underweight malnutrition calculated for the 6 provinces in this survey (35.4% and 21.3%, respectively) are slightly higher than the nationwide rates (31.9% and 18.9%, respectively). The reason may be that this survey was conducted only in rural areas while the nationwide survey was carried out in both urban and rural areas.

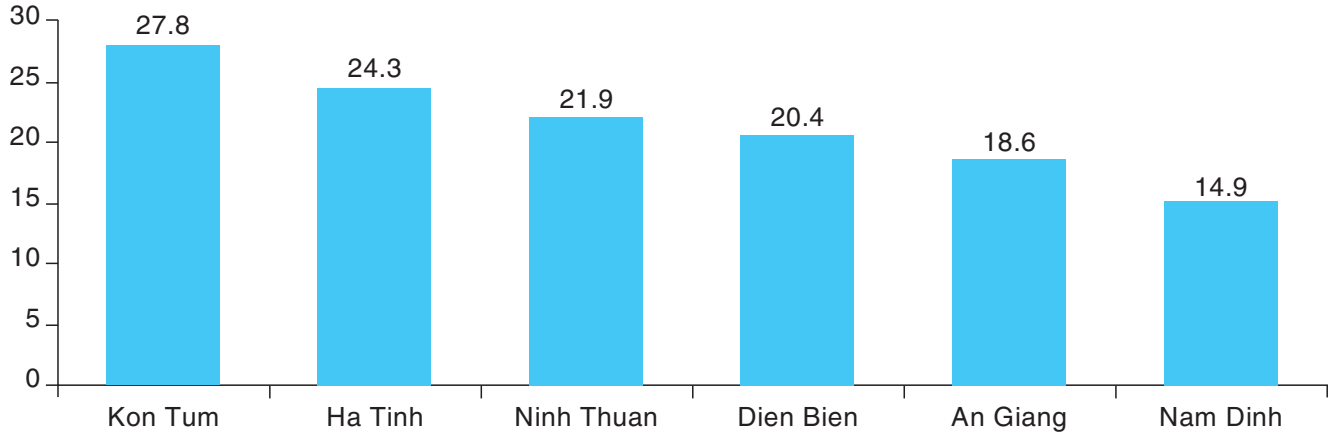
The rate of stunting malnutrition in this survey (35.4%) is also slightly higher than that of the developing countries in 2005 (32% of children under 5 suffered from stunting malnutrition).

Figure 3.2. The rate of stunting malnutrition, by province



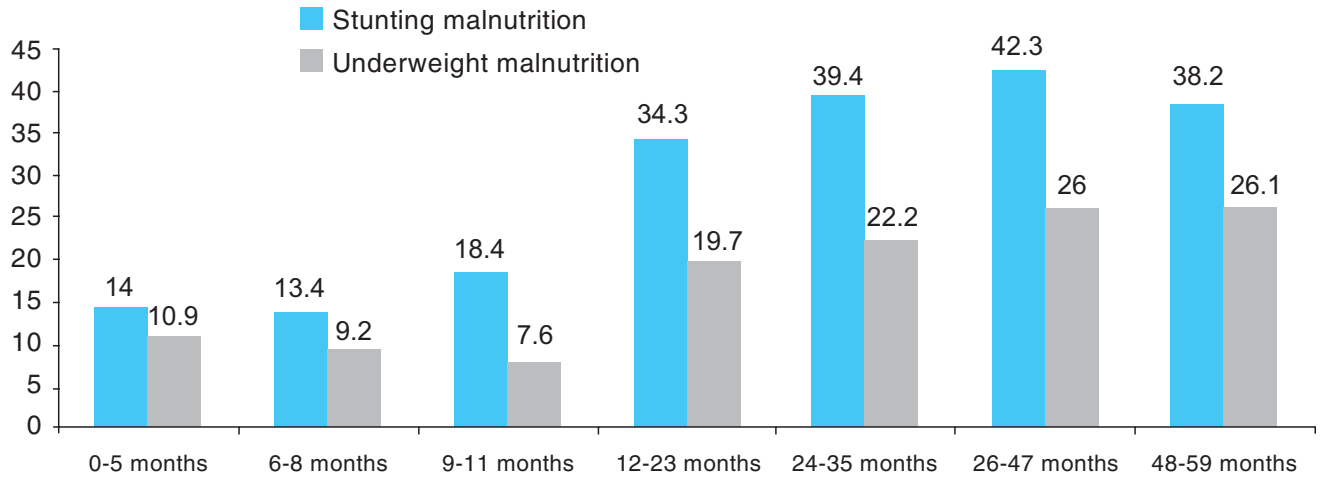
The rate of stunting malnutrition in children under 5 was found to be the highest in Kon Tum (46.4%), followed by Dien Bien (38.7%), Ha Tinh (38.2%), Ninh Thuan (36%), An Giang (29.5%) and the lowest in Nam Dinh (23.9%).

Figure 3.3. The rate of underweight malnutrition, by province



The rate of underweight children under 5 was found to be the highest in Kon Tum (27.8%), followed by Ha Tinh (24.3%), Ninh Thuan (21.9%), Dien Bien (20.4%), An Giang (18.6%) and lowest in Nam Dinh (14.9%).

Figure 3. 4. The rate of child malnutrition, by age



The rates of stunting and underweight malnutrition in different age groups of under one year children presented no significant difference. The child stunting and under-weight rates increased in proportion to the increase in age among children in the age cohorts of over one year and indicated an upward trend. It indirectly indicated that nutritional care and environmental sanitation clearly affected children's physical development. Therefore, good nutritional care and good hygiene practices for children would definitely help improve children's healthy physical development and prevent malnutrition.

Table 3.2. Some demographic characteristics related to malnutrition status in children under 5.

Group of characteristics		N	Stunting malnutrition		Underweight malnutrition	
			n	%	n	%
Child's gender	Boy	1667	597	35.8	350	21.0
	Girl	1689	592	35.1	364	21.6
Mother or main child caregiver's ethnic group	Kinh	2208	665	30.1	396	17.9
	Others	1148	524	45.6	318	27.7
Mother or main child caregiver's educational level	Illiterate, or only knowing how to read and write	968	434	44.8	278	28.7
	Primary school	867	289	33.3	162	18.7
	Secondary school	1038	331	31.9	195	18.8
	High school	324	101	31.2	59	18.2
	Intermediate school., college, university or higher	159	34	21.4	20	12.6
The number of children that a mother had	1	952	286	30.0	172	18.1
	2	1469	505	34.4	302	20.6
	3	557	221	39.7	118	21.2
	≥ 4	378	177	46.8	122	32.3
The number of generations	2	2165	787	36.4	462	21.3
	≥ 2	1191	402	33.8	252	21.2
Financial status	Poor	760	356	46.8	225	29.6
	Non-poor	2596	833	32.1	489	18.8
Area	Rural	1939	574	29.6	352	18.2
	Mountainous rural	1417	615	43.4	362	25.5

The study result shows that there was no significant gap between the rates of stunting and underweight between boys and girls.

The rates of stunting and underweight among Kinh children were considerably lower than those among other ethnic children.

The rates of both stunting and underweight children reduced in line with their mothers' education. The children whose mothers were illiterate or only knew how to read and write were more likely to suffer from stunting and underweight malnutrition than those whose mothers completed at least primary education.

The rates of child stunting and underweight gradually increased in line with the total number of children the mother had. The rates of stunting and underweight children born to mothers with only one child were lower than those of children born to mothers with more than one children.

The rates of child stunting and underweight show no significant difference between nuclear and non-nuclear families. The rates of stunting and underweight among children born to poor families were higher than those of children born to non-poor families.

The rates of stunting and underweight among children born to mothers living in the rural mountainous areas were higher than those of children born to mothers living in the rural plain areas.

3.2. Environmental sanitation, household water supply and hygiene behaviors of mothers for care of children under 5

3.2.1. Household water supply

In this study, water sources which were considered clean include rain water, dug well water, tube well water, tap water, and upstream water regardless specific water quality standards. Surface water from open rivers, streams, ponds and lakes is considered as unhygienic.

The main water sources in this survey were the sources used most widely for food preparation and daily household activities. Investigators directly observed the water supply and interviewed the households in order to classify the types of water source and fill in the data collection forms/questionnaires.

Table 3. 3. The main water sources in use

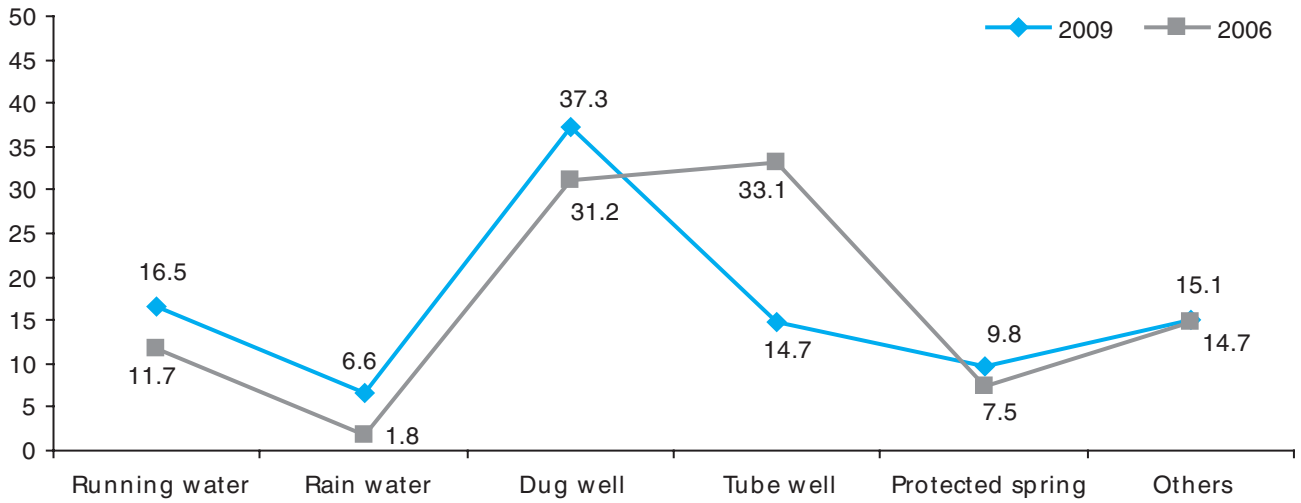
Water sources	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Tap water	8.0	0.6	3.0	0.2	41.3	43.8	16.5
Rainy water	20.4	0.6	14.8	0.5	1.5	0.4	6.6
Dug well water	10.8	36.6	63.2	79.4	39.8	0.8	37.3
Tube well water	60.3	4.0	17.6	1.5	1.9	0.8	14.7
Protected spring water	0.0	42.7	0.0	13.6	2.7	0.2	9.8
Surface water from streams, rivers, ponds or lakes	0.4	15.3	1.4	4.7	12.8	53.9	15.1

The study result shows that 84.9% of the households used water from clean water sources. Clean water sources used for food preparation and domestic activities were from dug wells (37.3%), followed by running taps (16.5%), tube wells (14.7%), protected springs (9.8%) and rain water collection (6.6%). Tap water was most commonly used in An Giang and Ninh Thuan (43.8% and 41.3%, respectively) whereas tube well water was most widely used in Ha Tinh (63.2%).

15.1% of the surveyed households were still using water from open streams, rivers, ponds

and lakes as the main water sources for preparing food and daily living, which was most commonly used in An Giang (53.9%), followed by Dien Bien (15.3%), Ninh Thuan (12.8%) and Nam Dinh (only 0.4%).

Figure 3. 5. The rates of household water sources in two surveys 2009 and 2006

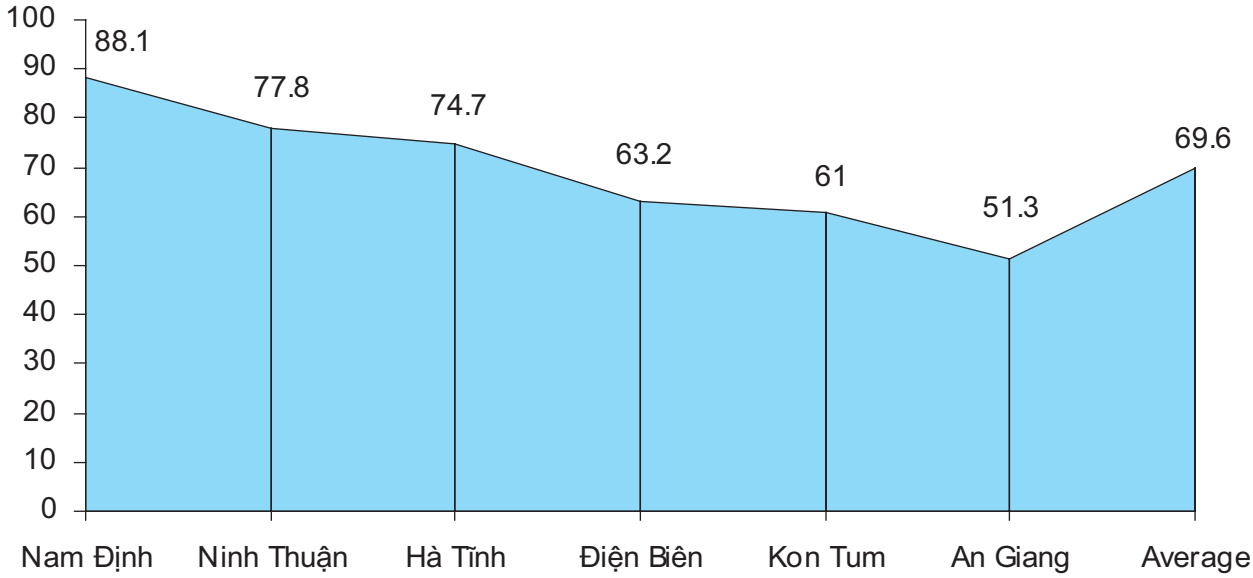


The pattern of water sources for food preparation and domestic activities in this study shows a slight divergence from that in the 2006 survey conducted by the Vietnam General Department of Preventive Medicine and Environmental Health [8], on 37,306 households in a total of 224 communes in 48 districts in 20 provinces in 8 ecological regions. The rate of households using tube well water in this study was much lower than that in the 2006 survey (14.7% vs. 33.1%) while the rates of households using other water sources in the two surveys show an insignificant difference.

The majority of the surveyed households had a sufficient amount of water for food preparation and daily activities while only 9.8% of the interviewed households had to save water or insufficient water. The rates of households lacking water for preparing food and daily living were found to be the highest in Kon Tum (26.3%) and Dien Bien (20.8%).

In order to assess the water quality, given that there is no possibility of testing water quality, the sensory evaluation was applied. The result of the sensory evaluation of the main water source is calculated according to the total number of the surveyed households, which is illustrated in the figure 3.6.

Figure 3.6. The rates of households using the main water sources which were considered as clean according to the sensory evaluation, by province



The water sources considered as hygienic water according to the sensory evaluation have to be clear, colorless, odorless and also have no unusual tastes that irritate the users. According to the opinions of the interviewees combined with the investigators' observation, 69.6% of the surveyed households used hygienic water sources. That means the rest of 30.4% of the surveyed households used unhygienic or contaminated water sources, in which the highest rate was found in An Giang (48.7%), followed by Kon Tum (39%), Dien Bien (36.8%), Ha Tinh (25.3%), Ninh Thuan (22.2%) and Nam Dinh (11.9%). The use of unclean water for food preparation and daily activities causes digestive diseases, eye diseases and skin diseases to community's people, especially children. Diseases, especially digestive ones, are the direct causes of child malnutrition.

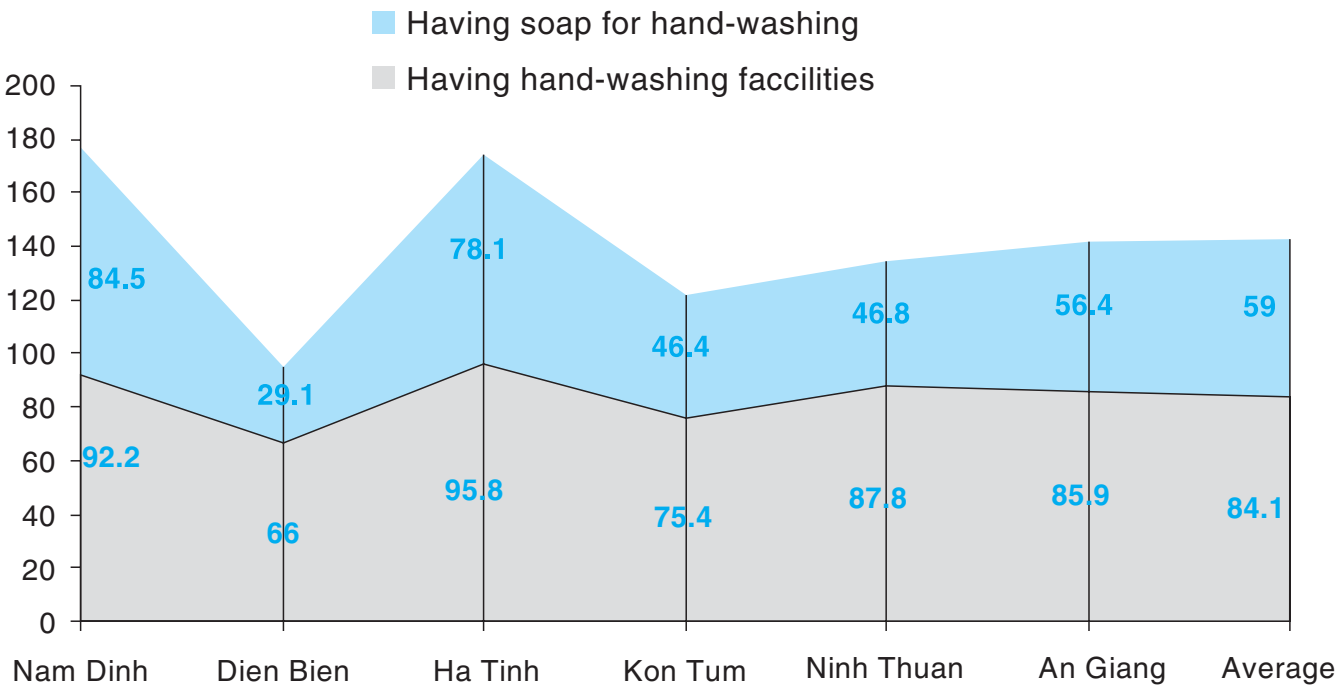
In order to assess if the water sources are hygienic or not, apart from the sensory evaluation, investigators used an observation checklist for scoring to identify levels of risks of water pollution (if a score of less than 3 is read, the risk is considered to be at low level; between 3 and 5, the risk at medium level; between 6 and 7, the risk at high level and between 8 and 9 at very high level). The study result assessed only four water sources (dug wells, tube wells, rain collection and protected springs) because tap water is considered as a water source with low risk of pollution, and water from open streams, rivers, ponds and lakes is regarded as very high risk of pollution. The risk level of those four water sources is presented in the table 3.4.

Table 3.4. The pollution risk level of water sources

Level of risk	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Low	80.2	48.2	68.8	51.9	72.0	45.3	61.3
Medium	13.7	33.4	27.7	26.6	11.8	0.6	18.8
High	5.5	2.8	2.2	15.9	3.3	0.2	4.6
Very high	0.6	15.6	1.4	5.7	12.9	53.9	15.3

The assessment result of pollution risk level of water sources shows that 61.3% of water sources have pollution risk at low level, 18.8% at medium level, 4.6% and 15.3% at high and very high level. The rate of households with water sources with high and very high levels of pollution risk was found to be the highest in An Giang (54.1%) and lowest in Ha Tinh (3.6%).

Figure 3.7. The rate of households having facilities and soap for washing hands



The observation results show that 84.1% of the surveyed households had hand-washing facilities, whereas the rest (15.9%) had none; particularly, the highest rate without hand-washing facilities was found in Dien Bien (34%) and Kon Tum (24.6%), and the lowest in Ha Tinh (4.2%).

Although 84.1% of the surveyed households had facilities for hand-washing, only 59% had bar soap/gel soap at the facilities. The rate of households without soap in the hand-washing

facilities was very high in Dien Bien (70.9%), followed by Kon Tum (53.6%), An Giang (43.6%) and Ninh Thuan (43.2%).

3.2.2. Latrines and use of human feces in agriculture

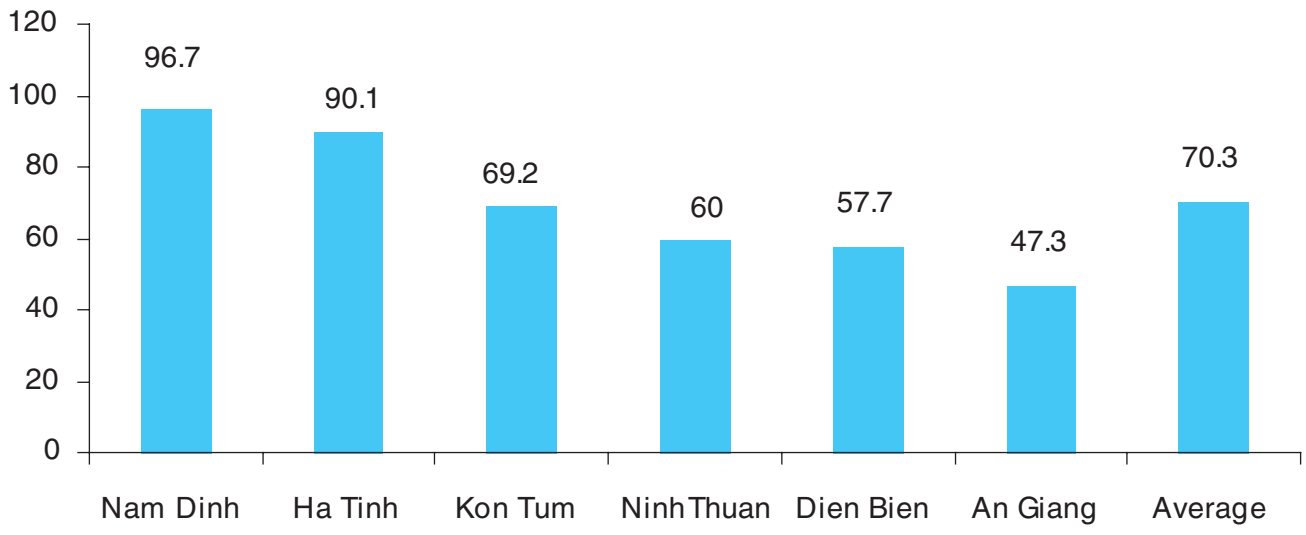
Table 3.5. The rate of households with latrines, by type of latrine

Province	With latrines	With sanitary Latrines by names	With latrines meeting MOH construction standard	With latrines meeting MOH O&M standards	With latrines
Nam Dinh	96.7	71.4	63.6	62.4	59.7
Dien Bien	57.7	8.3	5.3	5.5	4.3
Ha Tinh	90.1	53.4	38.5	31.2	25.9
Kon Tum	69.2	15.6	11.7	11.2	10.2
Ninh Thuan	60.0	58.9	50.8	52.2	45.9
An Giang	47.3	41.2	39.2	37.4	36.6
Total	70.3	42.2	35.5	33.9	30.9

The table 3.5. shows that 70.3% of the surveyed households in the 6 provinces had latrines. 42.2% of households had hygienic types of latrines by names, 35.5% had latrines meeting the construction standards , 33.9% had latrines meeting standards of operation and maintenance, and 30.9% had latrines meeting both standards of construction; and of operation and maintenance. The status of latrines is hereafter analyzed in depth and evaluated by using the 5 above mentioned indicators.

3.2.2.1. The rate of households with latrines

Figure 3.8. The rate of households with latrines



The rate of surveyed households with latrines accounted for 70.3%. By province, the highest rate was found in Nam Dinh (96.7%) and followed by Ha Tinh (90.1%) and the lowest in An Giang (47.3%) and the second lowest in Dien Bien (57.7%). This rate in this study was slightly lower than that in the National survey on environmental sanitation conducted by the Vietnam General Department of Preventive Medicine and Environmental Health in 2006 (75%).

Among the remaining 29.7% of the households with no latrines, the rate of households without latrines was found to be the highest in An Giang (52.7%), followed by Dien Bien (42.3%), Ninh Thuan (40%), Kon Tum (30.8%), Ha Tinh (9.9%) and Nam Dinh (3.3%). The status of no latrines at the household level confirmed existence of open defecation, consequently causing polluted surrounding and spreading worms, parasites and germs into the environment.

3.2.2.2. The rate of households with hygienic latrines

Table 3.6. The proportion of each type of household latrines by names:

Type of latrine	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Septic tank	65.6	2.4	17.2	11.7	41.7	17.0	26.0
Double vault	2.0	5.1	35.0	0.2	0.2	0.0	7.4
Ventilated pit	0.0	0.2	0.2	2.2	0.4	0.0	0.4
Pour flush	2.5	0.6	0.6	1.2	16.6	24.2	7.7
Biogas	1.2	0.0	0.4	0.2	0.0	0.0	0.3
All the 5types of latrines	71.4	8.3	53.4	15.6	58.9	41.2	42.2
Other	25.4	49.4	36.8	53.6	1.0	6.1	27.8

The study result shows that 42.2% of the surveyed households had hygienic latrines by names (septic tank, pour-flush, double-vault, ventilated pit and Biogas), but it did not take into consideration whether or not those latrines met hygiene standards of construction, operation and maintenance specified in the MOH Decision 08/2005/QD-BYT.

The total of 42.2% of households with the above five types of was accumulated from the 26% of households with septic tank latrines, 7.7% with pour-flush latrines, 7.4% with double-vault latrines, 0.4% with ventilated pit latrines and 0.3% with Biogas latrines. The rate of households with septic tank latrines was found to be the highest in Nam Dinh and Ninh Thuan (65.6% and 41.7%, respectively) and the lowest in Dien Bien (2.4%).

27.8% of the surveyed households used unhygienic latrines such as single-vault latrines, bucket latrines, and fish pond hanging latrines. The rate of households with these types of latrines was found to be high in Kon Tum (53.6%), Dien Bien (49.4%) and Ha Tinh (36.8%).

Following is the comparison of the rate of households having the five hygienic types of latrines by regions, which was found in this study, the National Survey on Environmental sanitation conducted by MOH and UNICEF (1997); the National Health Survey conducted by MOH (2002) and the National Survey on Environmental sanitation conducted by MOH and UNICEF (2006).

Table 3.7. Comparison between rates of hygienic latrines in this study and those from other data sources

Ecological region	National Survey on Environmental sanitation 1997 (MOH)*	National Health Survey 2002 (MOH)**	Survey on Rural Environmental sanitation 2006 (MOH)***	This study
Red River delta	3.5	32	37.9	71.4
Northeast	2.4	27	10.2	-
Northwest		4	6.2	8.3
North Central	6.5	33	43.8	53.4
South Central	11.4	21	49.6	58.9
Central highlands	1.3	12	13.3	15.6
Southeast	7.2	37	53.8	-
Mekong River delta	4.3	12	26.1	41.2
Total	**4.8**	**21.0**	**33.0**	**42.2**

** MOH-UNICEF (1997), National survey on household latrines in rural Viet Nam*

*** MOH (2002), National health survey*

**** MOH (2006), National survey on environmental sanitation*

The table 3.7. shows that there were differences in the rates of hygienic latrines among different data sources; however, there was an upward trend showing progress made over time. According to this study result, the rate of households with hygienic types of latrines by names was 42.2%, higher than that of the National Survey on Environmental sanitation in 2006 (33%), the National Health Survey in 2002 (21%) and the National Survey on Environmental sanitation in 1997 (4.8%). This increasing trend might result from socio-economic development and effectiveness of projects, programs through communication and advocacy in supporting communities and households to increase the coverage of hygienic types of latrines in rural areas. However, the rate of families with hygienic types of latrines was still low, especially in the Northwest, Northeast and Central Highlands regions of the country.

3.2.2.3. The rate of hygienic latrines meeting hygiene standards of construction according to the MOH Decision 08/2005/QD-BYT

Having hygienic types of latrines by names is an initial condition for a latrine meeting the MOH hygienic standards; however, the latrine needs to comply with other two standards (construction and O & M) to become a hygienic latrine defined in the MOH Decision 08/2005/QD-BYT. To ensure if one household meets the construction standards or not, in the field, the study team visited the household , interviewed family members and used the observation checklist of the construction standards (see the appendix) stated in the MOH Decision 08/2005/QD-BYT for their determination.

Table3.8. The rate of latrines meeting the construction standards of per the number of surveyed households

Type of latrine	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Septic tank	59.5	2.0	16.8	10.2	40.0	16.4	**24.4**
Double vault	1.0	2.8	20.8	0.2	0.2	0.0	**4.4**
Ventilated pit	0.0	0.2	0.0	0.5	0.4	0.0	**0.2**
Pour flush	1.8	0.2	0.6	0.5	10.2	22.8	**6.2**
Biogas	1.2	0.0	0.4	0.2	0.0	0.0	**0.3**
Total	**63.6**	**5.3**	**38.5**	**11.7**	**50.8**	**39.2**	**35.5**

The study result shows that only 35.5% of all surveyed households had hygienic latrines meeting the construction standards according to the MOH Decision 08/2005/QD-BYT. The septic tank latrines met the MOH construction standards at the highest rate of 24.4%, followed by pour-flush latrines of 6.2%, double-vault latrines of 4.4%, ventilated pit latrines of 0.2% and Biogas latrines of 0.3%.Nam Dinh province had the highest rate (63.6%) of latrines meeting construction standards , while Dien Bien had the lowest rate (5.3%).

Table 3.9. The rate of latrines meeting MOH construction standards among the households with hygienic latrines by names

Type of latrine	Nam Dinh (n=349)	Dien Bien (n=41)	Ha Tinh (n=270)	Kon Tum (n=63)	Ninh Thuan (n=284)	An Giang (n=204)	Total (n=1211)
Septic tank	90.7	83.3	97.7	87.2	96.0	96.4	**93.2**
Double vault	50.0	56.0	59.3	100.0	100.0	0.0	**58.9**
Ventilated pit	0.0	100.0	0.0	22.2	100.0	0.0	**38.5**
Pour flush	75.0	33.3	100.0	40.0	61.3	94.2	**79.4**
Biogas	100.0	0.0	100.0	100.0	0.0	0.0	**100.0**
Total	**89.1**	**63.4**	**72.2**	**74.6**	**86.3**	**95.1**	**84.1**

The study result shows that 84.1% of the households with hygienic latrines by names, that met the construction standards according to the MOH Decision 08/2005/QD-BYT. The highest rate was found in An Giang (95.1%) and lowest in Dien Bien (63.4%). Biogas latrines met the MOH construction standards at the highest rate of 100%, followed by septic tank latrines of 93.2%, pour-flush latrines of 79. 4%, double-vault latrines of 58.9% and ventilated pit latrines of only 38.5%.

3.2.2.4. The rate of hygienic latrines by names meeting the operation and maintenance standards according to the MOH Decision 08/2005/QD-BYT

Apart from the construction standards , a hygienic latrine has to embrace all operation and maintenance standards . Even if a latrine meets the construction standards but not the operation and maintenance standards, it is not considered as hygienic, according to the MOH Decision 08/2005/QD-BYT.

Table 3.10. The rate of latrines meeting the operation and maintenance standards of, per the number of surveyed households

Type of latrine	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	**Total (n=2869)**
Septic tank	58,3	2.2	15.2	9.4	36.9	14.7	**23.1**
Double vault	1.0	2.6	14.8	0.2	0.2	0.0	**3.3**
Ventilated pit	0.0	0.0	0.2	0.2	0.4	0.0	**0.1**
Pour flush	1.8	0.6	0.6	1.0	14.9	22.6	**7.1**
Biogas	1.2	0.0	0.4	0.2	0.0	0.0	**0.3**
Total	**62.4**	**5.5**	**31.2**	**11.2**	**52.5**	**37.4**	**33.9**

The study result shows that only 33.9% of the all surveyed households had hygienic latrines meeting the operation and maintenance standards according to the MOH Decision 08/2005/QD-BYT. Septic tank latrines met the MOH operation and maintenance standards at the highest rate of 23.1%, followed by pour-flush latrines of 7.1%, double-vault latrines of 3.3%, ventilated pit latrines of 0.1% and Biogas latrines of 0.3%.The highest rate of latrines (62.4%) meeting the operation and maintenance standards was found in Nam Dinh province while the lowest was in Dien Bien (5.5%).

Table 3.11. The rate of latrines meeting O&M standards among households with hygienic latrines by names

Type of latrine	Nam Dinh (n=349)	Dien Bien (n=41)	Ha Tinh (n=270)	Kon Tum (n=63)	Ninh Thuan (n=284)	An Giang (n=204)	Total (n=1211)
Septic tank	88.8	91.7	88.5	80.9	88.6	86.9	**88.0**
Double vault	50.0	52.0	42.4	100.0	100.0	0.0	**44.4**
Ventilated pit	0.0	0.0	100.0	11.1	100.0	0.0	**30.8**
Pour flush	75.0	100.0	100.0	80.0	90.0	93.3	**91.0**
Biogas	100.0	0.0	100.0	100.0	0.0	0.0	**100.0**
Total	**87.4**	**65.9**	**58.5**	**71.4**	**89.1**	**90.7**	**80.3**

The study result shows that 80.3% of the households had hygienic latrines by names meeting the O & M standards according to the MOH Decision 08/2005/QD-BYT. The highest rate of latrines meeting the O & M standards was found in An Giang (89.1%) while the lowest in Ha Tinh (58.5%). Again, Biogas latrines met the MOH operation and maintenance standards at the highest rate of 100%, followed by pour-flush latrines of 91%, septic tank latrines of 88%, double-vault latrines of 44.4%, and ventilated pit latrines of 30.8%.

3.2.2.5. The rate of latrines meeting both construction standards and operation and maintenance standards according to the MOH Decision 08/2005/QD-BYT.

A latrine is considered as hygienic according to the MOH Decision 08/2005/QD-BYT if it meets both construction standards and operation and maintenance standards.

Table 3.12. The rate of latrines meeting both construction standards and operation and maintenance standards, per the number of surveyed households

Type of latrine	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	**Total (n=2869)**
Septic tank	56.0	1.8	15.0	8.9	35.9	14.7	**22.3**
Double vault	0.8	2.2	9.9	0.2	0.2	0.0	**2.3**
Ventilated pit	0.0	0.0	0.0	0.2	0.4	0.0	**0.1**
Pour flush	1.6	0.2	0.6	0.5	9.3	21.8	**5.8**
Biogas	1.2	0.0	0.4	0.2	0.0	0.0	**0.3**
Total	**59.7**	**4.3**	**25.9**	**10.2**	**45.9**	**36.6**	**30.9**

The study result shows that 30.9% of the all surveyed households have latrines meeting both construction standards and operation and maintenance standards according to MOH Decision 08/2005/QD-BYT. The highest rate of latrines meeting both construction standards and operation and maintenance standards was that of septic tank latrines (22.3%), followed by pour-flush latrines (5.8%), double-vault latrines (2.3%), ventilated pit latrines (0.1%) and Biogas tank latrines (0.3%).Nam Dinh was the province with the highest rate of latrines meeting both construction standards and operation and maintenance standards while Dien Bien was with the lowest.

Table 3.13. The rate of latrines meeting both construction standards and operation and maintenance standards among the households with hygienic latrines by names

Type of latrine	Nam Dinh (n=349)	Dien Bien (n=41)	Ha Tinh (n=270)	Kon Tum (n=63)	Ninh Thuan (n=284)	An Giang (n=204)	Total (n=1211)
Septic tank	85.4	75.0	87.4	76.6	86.1	86.9	**85.2**
Double vault	40.0	44.0	28.2	100.0	100.0	0.0	**31.3**
Ventilated pit	0.0	0.0	0.0	11.1	100.0	0.0	**23.1**
Pour flush	66.7	33.3	100.0	40.0	56.3	90.0	**74.9**
Biogas	100.0	0.0	100.0	100.0	0.0	0.0	**100.0**
Total	**83.7**	**51.2**	**48.5**	**65.1**	**77.8**	**88.7**	**73.2**

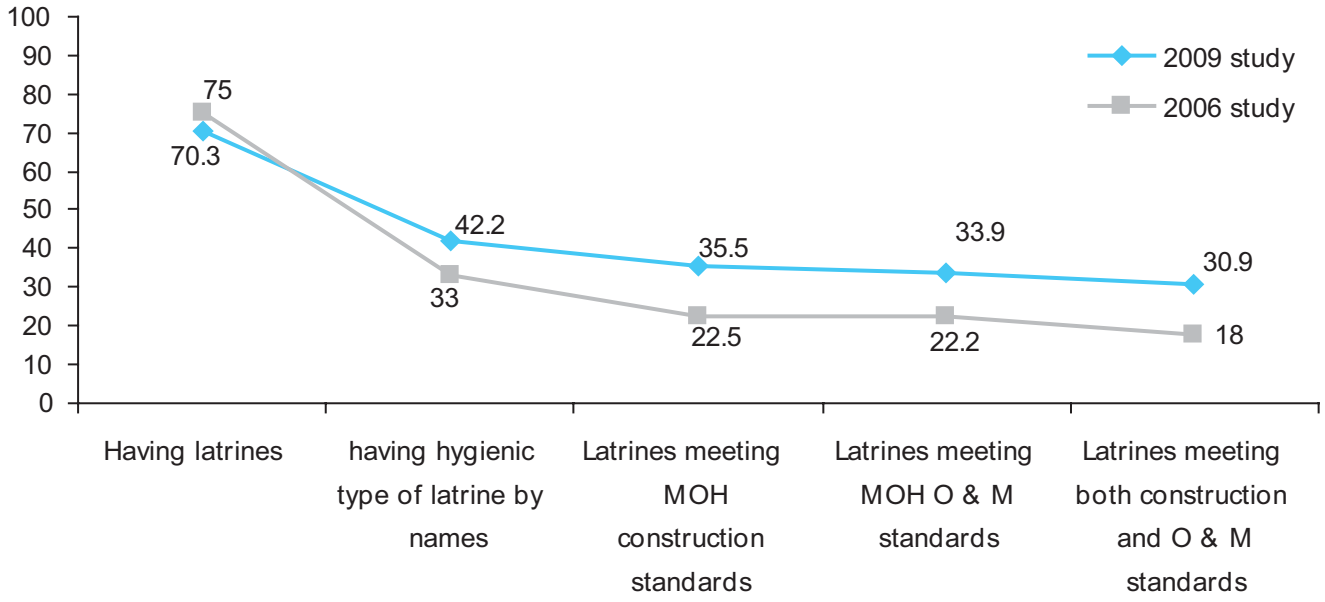
The study result shows that 73.2% of the households with hygienic latrines by names had latrines meeting the MOH construction standards and operation and maintenance standards The highest rate of hygienic latrines meeting both construction standards and operation and maintenance standards was found in Nam Dinh (83.7%) and the lowest in Ha Tinh (48.5%). Biogas latrines met the MOH Decision 08/2005/QD-BYT hygienic standards of latrines at the highest rate of 100%, followed by septic tank latrines of 85.2%, pour-flush latrines of 74.9%, double-vault latrines of 31.3%, and ventilated pit latrines of 23.1%.

3.2.2.6. Comparison between the results of the 2009 and 2006 surveys on latrines

In some studies and surveys on latrines, only the National Survey on Environmental sanitation in 2006 offered a comprehensive and complete assessment as per both quantity and quality according to the MOH Decision 08/2005/QD-BYT of hygienic standards of latrines.

The results of the 2009 study were compared with those of the 2006 survey and illustrated in the following figure.

Figure 3.9. Some information on latrines, per the number of the surveyed households, between the two surveys in 2009 and 2006

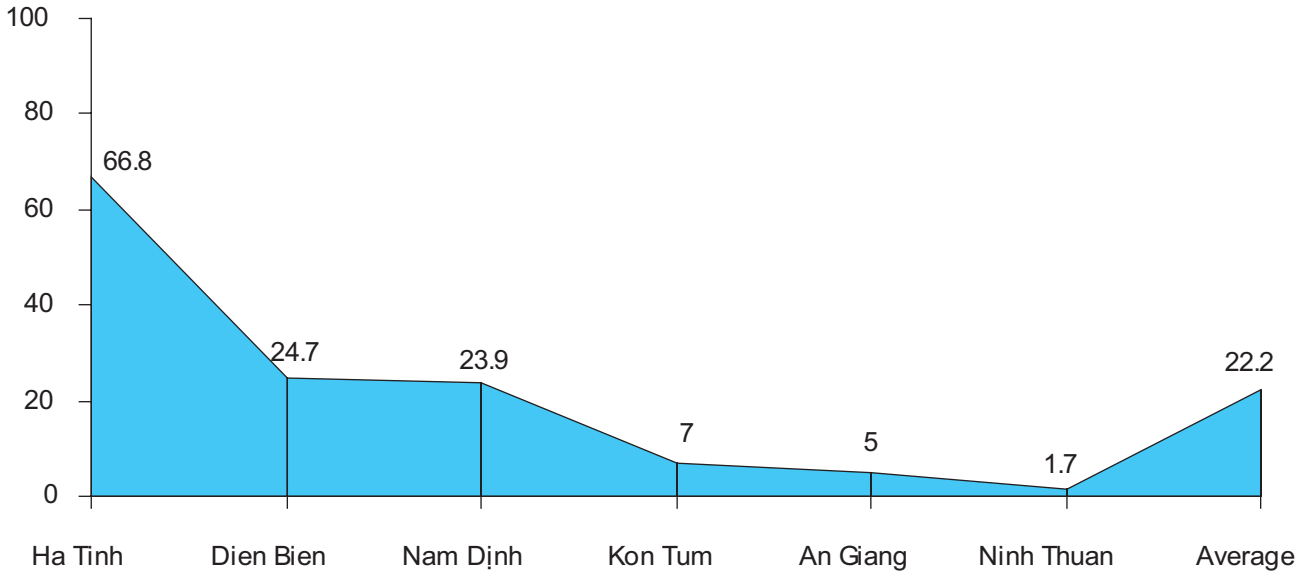


The study result shows that 70.3% of the all surveyed households had latrines, slightly lower than the result of the National Survey on Environmental sanitation conducted by Vietnam General Department of Preventive Medicine and Environmental Health in 2006 (75%). The rate of households with hygienic latrines by names (septic tank, pour-flush, double-vault, ventilated pit and Biogas) in this study was 42.2% of the total number of surveyed households, higher than that of the National Survey on Environmental sanitation in 2006 (33%). The rate of households with latrines meeting both construction and operation and maintenance standards according to the MOH Decision 08/2005/QD-BYT was higher than that of the National Survey on Environmental sanitation in 2006 (30.9% vs. 18%).

Thus, project/ programs with the purpose of increasing the rate of latrine coverage should focus mainly on the hygienic types of latrines, as well as the quality of construction, operation and maintenance. It is important to strengthen the communication among the public in order to encourage people to erect household latrines, consult them on choosing the types of latrines that are suitable to their financial condition and especially guide them to construct, operate and maintain the latrines so that their latrines remain sanitary and meet hygiene standards.

3.2.2.7. The situation of treating and using human feces

Figure 3.10. The rate of households using human feces for fertilization and food for fish



This study found out that 22.2% of the households used human feces to fertilize their crops or to feed the fish. Ha Tinh was found to be with the highest rate of 66.8% whereas Ninh Thuan with the lowest of 1.7%.

Using untreated human feces to fertilize crops increases the possibility of spreading worm eggs and harmful bacteria/viruses to the environment and transmitting infectious diseases to the community. The study result shows that 15.1% of all the households used the untreated human feces for fertilization/ food for fish.

Composting human feces before using it to fertilize crops helps kill worm eggs and harmful bacteria; however, according to MOH's recommendation, only human feces composted for at least 6 months can kill germs, parasites and harmful bacteria and viruses. The study result indicates that 32.6% of the households which applied composting of human feces did it properly for at least 6 months before using it, while the remaining 62.2% of them applied compost for less than 6 months.

Table 3.14. Treatment of children's feces

Method of treatment	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Dispose in latrines	93.5	30.6	80.0	44.7	53.5	47.9	58.8
Bury in household yards/gardens	0.6	3.4	3.0	8.9	12.4	3.8	5.2
Dispose in garbage containers	0.0	0.2	0.4	0.2	2.3	0.8	0.7
Dispose in household yards	0.0	5.5	0.4	2.2	1.9	1.0	1.8
Dispose in gardens	4.7	35.8	15.2	24.6	12.4	6.3	16.3
Dispose in fields/rivers	4.5	17.8	2.0	2.2	14.1	38.8	13.6
Use as food for dogs and/or pigs	7.8	49.8	17.0	41.9	8.5	4.8	21.1
Others	1.0	0.8	1.2	3.0	3.7	9.3	3.2

Only 58.8% of the mothers handled children's feces in a correct way, which is disposing it in the latrines; the highest rate was found in Nam Dinh (93.5%) and Ha Tinh (80%) while the lowest was in Dien Bien (30.6%). Thus, 41.2% of the mothers dealt with children's feces in improper ways such as using it as food for dogs and/or pigs (21.1%), disposing it in the gardens (16.3%) or in fields/rivers (13.6%). The rate of mothers handling children's feces in improper ways was high in the mountainous provinces (Dien Bien 85.6% and Kon Tum 66.5%). An Giang is one of Mekong River delta province with a very busy system of canals the incorrect handling of children's feces – disposing it in the fields/rivers (38.8%) – is quite common.

3.2.3. Hygiene behaviors of mothers

Table 3.15. The mothers' hand-washing practices

The frequency of hand-washing	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Usually	81.4	58.1	76.3	62.8	78.4	78.4	72.5
Sometimes	16.6	36.2	21.3	31.0	17.4	17.4	23.8
Rarely	2.0	5.7	2.4	6.2	4.1	4.1	3.7

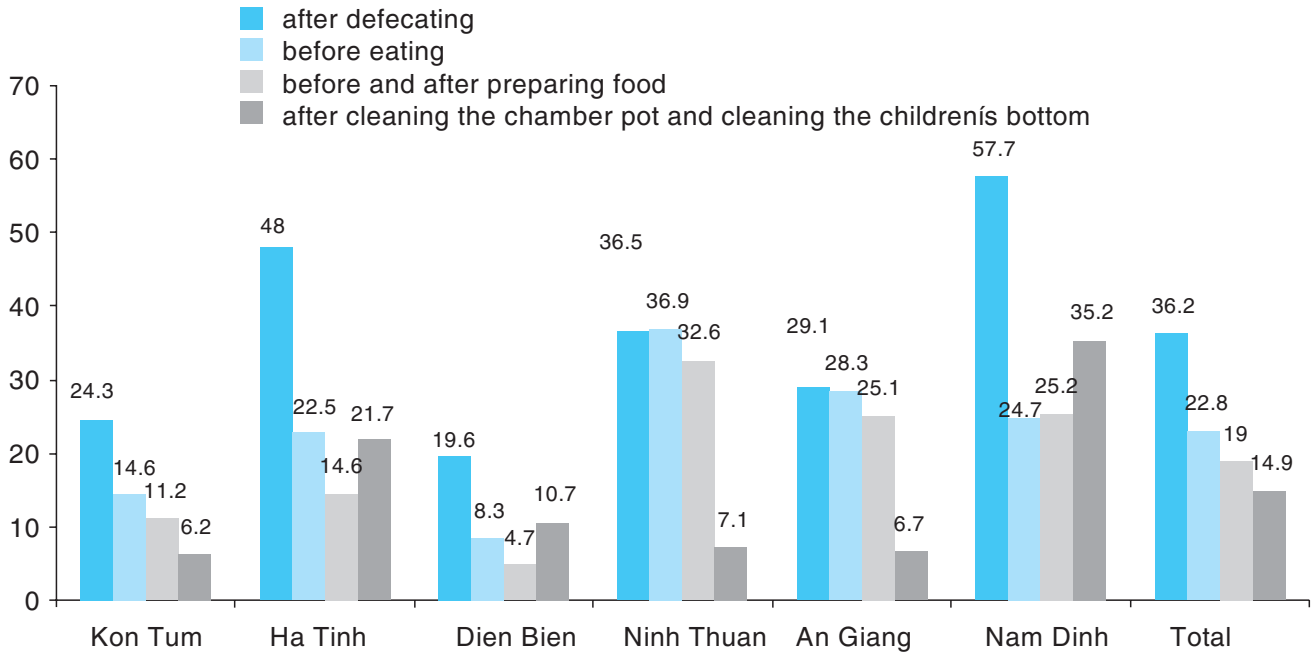
When questioned: "How often do you wash your hands?", 72.5% of the respondents answered "usually", 23.8% sometimes and 3.7% rarely. The rate of respondents answering "sometimes or rarely" was found to be the highest in Dien Bien (41.9%) and Kon Tum (37.2%) and lowest in Nam Dinh (18.6%).

Hand-washing with soap is considered the cheapest, but also a more effective option to prevent diseases such as diarrhea, parasitic/worm diseases and respiratory infection than

other options in the intervention programs on safe water and environmental sanitation. Scientists found that every 1 cm^2 of human body skin is home to 40,000 bacteria. The figure is even higher on hand skin because the hands always touch various objects. According to WHO, only one single behavior of hand-washing can reduce the infection of Shigella, which causes diarrhea and globally prevent thousands of deaths every year by 35%. Some research confirms that hand-washing can reduce the risk of diarrhea by 47% and respiratory infections by 19-45%. Hand-washing is called a do-it-yourself vaccine, which is feasible, cost-effective and able to save millions of lives [36].

The habit of hand-washing before eating and after urinating/defecating helps remove germs which spread from contaminated hands to food, drinking water and then to the human body, and therefore, prevent them from causing life-threatening diseases to humans. The result of the survey on mothers' hand-washing behavior at critical times is illustrated in the following figure.

Figure 3. 11. The rate of mothers usually washing hands with soap among the interviewed mothers



Of all interviewed mothers, 36.2% of them told to often wash their hands with soap after defecating, 22.8% before eating, 19% before and after preparing food and 14.9% after helping babies go to the toilets and cleaning the children's bottom.

Table 3.16. Comparison of the rates of mothers usually washing hands with soap with some other studies

The frequency of hand-washing	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Usually	81.4	58.1	76.3	62.8	78.4	78.4	72.5
Sometimes	16.6	36.2	21.3	31.0	17.4	17.4	23.8
Rarely	2.0	5.7	2.4	6.2	4.1	4.1	3.7

The result of this survey is higher than that of the National Survey on Environmental sanitation in 2006 (12% of the interviewees washed hands with soap before eating, 12.2% practiced hand-washing with soap after urination and 15.6% after defecation), and also higher than the result of the survey conducted in the 390 mothers with children under 5 years in 10 communes in 5 provinces of Ha Tinh, Thanh Hoa, Ha Nam, Ha Tay and Hai Phong in 2007 old (22% of mothers washed hands with soap after defecating, 0.8% after urinating, 2.6% before feeding their children, 10.5% after cleaning the children's bottom and 16.1% after disposing of the children's feces).

In this study, the rate of interviewees washing hands with soap after defecation was found to be the highest in Nam Dinh (57.7%), followed by Tinh (48%), and lowest in Dien Bien (19.6%). The rate of interviewees who washed hands with soap before eating was found to be the highest in Ninh Thuan (36.9%) and lowest in Dien Bien (8.3%). The rate of interviewees who washed hands with soap before and after preparing food was found to be the highest in Ninh Thuan (32.6%) and the lowest in Dien Bien (4.7%). The rate of interviewees who washed hands with soap after cleaning the chamber pot and cleaning the children's bottom was found to be the highest in Nam Dinh (35.2%) and lowest in Kon Tum (6.2%).

Table3.17. Considerations of the mothers when buying food

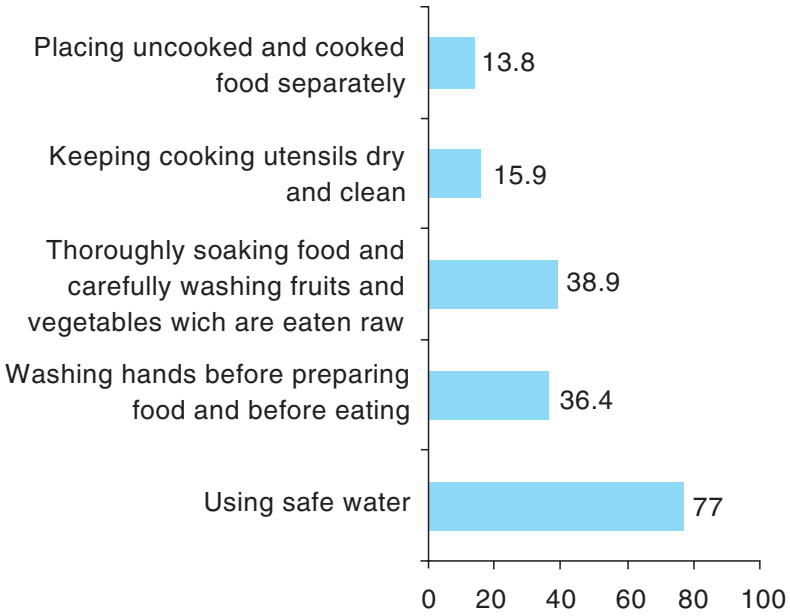
Consideration	Nam Dinh (n=489)	Dien Bien (n=494)	Ha Tinh (n=506)	Kon Tum (n=403)	Ninh Thuan (n=482)	An Giang (n=495)	Total (n=2869)
Buying fresh food	97.5	78.1	89.7	68.0	88.8	92.7	86.4
Buying food with verified origin	22.5	7.3	21.1	8.4	12.0	8.1	13.4
Others	1.8	4.7	1.0	5.5	5.4	4.4	3.7
Having no knowledge	0.4	13.8	2.0	27.0	8.7	48	8.9

As for the question: "What are you concerned about when buying food?" 86.4% answered that it's the freshness of the food, only 13.4% were concerned about sources of food supply

and 8.5% of mothers did not know what they should be concerned about when buying food. The rate of interviewees who were unaware of, what they should be concerned about, when buying food, was quite high in Kon Tum (27%) and Dien Bien (13.8%).

The most important thing to ensure the hygiene of food preparation for families is using safe water. 77% of the interviewees confirmed their use of safe water in food preparation. The other factors of equal importance of hand washing, cleaning food , fruits and vegetables, keeping kitchen utensils clean and keeping raw and cooked food apart from each other, which many respondents did not mention. Only 36.4% confirmed their washing hands before preparing food and before eating, 38.9% their thoroughly cleaning the food, carefully washing fruits and vegetables which are eaten raw, 15.9% their keeping cooking utensils dry and clean and 13.8% their placing uncooked and cooked food apart from each other.

Figure 3. 12. Necessary activities to ensure hygiene food preparation



The rate of interviewees giving correct and sufficient answers to what should be done to ensure the hygiene of cooked and stored food was low. These practices include: eating only well cooked food immediately after cooking (51.9%), covering and storing the food properly (59.9%), refusing spoilt food (40.1%) and cooking the stored food well again before eating (38.1%).

Figure 3. 13. Necessary practices to ensure hygiene in using and storing food

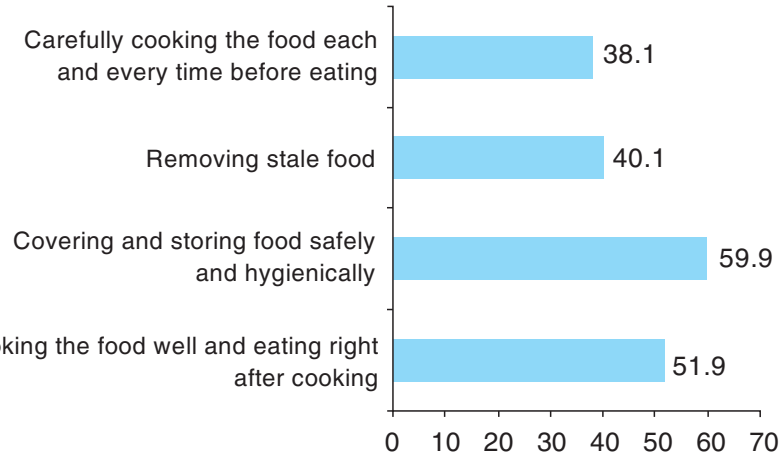
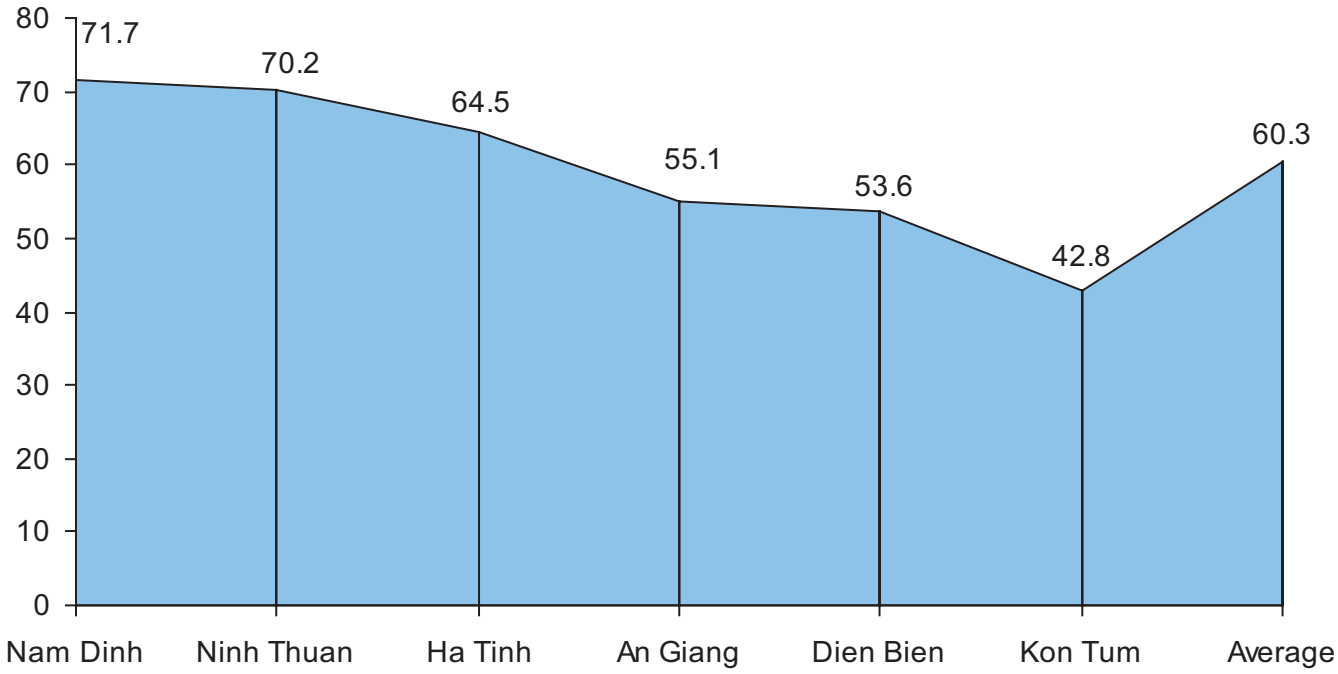


Figure 3. 14. The rate of children provided with de-worming medicine during the past 6 months



According to MOH's recommendation, children above 24 months should be de-wormed every six months. The result of this survey indicates that 39.6% of all the surveyed families had not had their children de-wormed during the past six months. The rate of families without providing their children with de-worming medicine for the past six months was found to be the highest in Kon Tum (57.2%), followed by Dien Bien (46.4%), An Giang (44.9%), Ha Tinh (35.5%), Ninh Thuan (29.8%) and Nam Dinh (28.3%).

3.3. Relation between household environmental sanitation and household water supply, hygiene behaviors of mothers and the nutritional status of children under 5

3.3.1. Single-variable relation between the nutritional status of children under 5 and some related factors

To analyze the relation in comparison of two groups, the simple logistic regression model that was adjusted by gender and age of children using Chi-square test (÷2) and odds ratio (OR), was used.

3.3.1.1 Relation between child malnutrition and other single variables at community level

Table 3.18. Relation between child malnutrition with other single variables at the community level

Variable	Underweight malnutrition					Stunting malnutrition			
	Malno-urished	Well-nourished	OR	CI 95%	p	Malnourished	Well-nourished	OR	CI 95%
Commune groups with various levels of rates of un-hygienic types of household latrines									
Low rate of unhygienic latrines	214	924	-			351	787	-	
Average rate of unhygienic latrines	200	878	**1.13**	0.79-1.61	0.52	326	752	**1.10**	0.81 - 1.51
High rate of unhygienic latrines	300	840	**1.63**	1.16 -2.3	0.01	512	628	**2.05**	1.51 - 2.77
Commune groups with various levels of rates of un-hygienic household latrines									
Low rate of unhygienic latrines	196	920	-			308	808	-	
Average rate of unhygienic latrines	214	887	**1.08**	0.76-1.54	0.66	364	737	**1.29**	0.95 - 1.74
High rate of unhygienic latrines	304	835	**1.72**	1.23 - 2.41	0.00	517	622	**2.28**	1.7-3.06
Commune groups with various levels of rates of un-hygienic household water supply									
Low rate of un-hygienic water supply	182	936	-			306	812	-	
Average rate of un-hygienic water supply	225	879	**1.39**	0.98-1.97	0.07	394	710	**1.48**	1.09 - 2.01
High rate of un-hygienic water supply	307	827	**1.95**	1.39-2.74	0.00	489	645	**2.10**	1.55 - 2.85
Commune groups with various levels of rates of households using human excreta composted for < 6 months									
Low rate of households using human excreta composted for < 6 months	206	691	-			358	539	-	
Average rate of households using human excreta composted for < 6 months	261	1004	**0.94**	0.64-1.37	0.73	447	818	**0.85**	0.6-1.19
High rate of households using human excreta composted for < 6 months	247	947	**0.95**	0.65-1.39	0.78	384	810	**0.76**	0.54 - 1.08

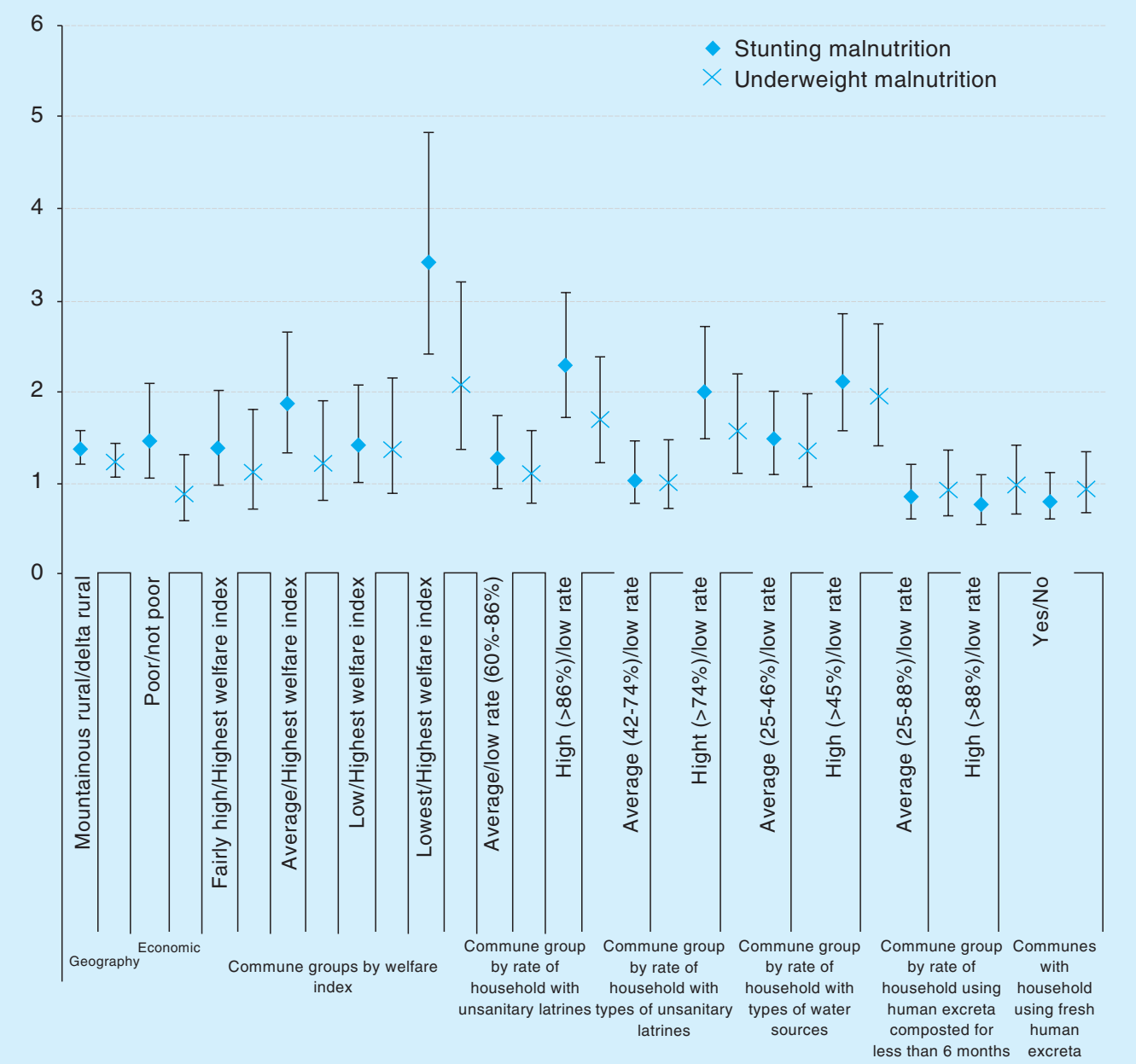
At the community level, the study result presents the relation between child malnutrition and some related factors at different levels. The difference in the rates of child stunting and underweight malnutrition was clearly affected by many factors.

The unhygienic latrines in this study included having no latrines or having other latrines than the 5 hygienic latrines by names: septic tank, pour flush, double vault, ventilated improved pit and biogas. If the households with unhygienic latrines were divided into 3 equal groups for comparison, they would be as follows: group with low rate of unhygienic latrines, group with average rate of unhygienic latrines, and group with high rate of unhygienic latrines. The table above shows that the rate of child stunting and underweight malnutrition in the group with high rate of unhygienic latrines was considerably higher ($p<0.001$) (2.05 and 1.63 respectively) than that in the group with low rate of unhygienic latrines. The rate of stunting and underweight malnutrition in the commune group with high rate of latrines that did not meet the standards (construction and O&M according to the Decision No.08/2005/QD-BYT) was considerably higher (2.28 and 1.72 respectively) than that in the group with low rate of unhygienic latrines ($p<0.001$).

The hygienic water sources include running water, rain water, dug well water, tube well water or protected spring water, which meet the sensory standards and have no risks or low-level of pollution. If the households with unhygienic water sources were divided into 3 equal groups for comparison (one with low rate, one with average rate and one with high rate), it shows that the rate of underweight malnutrition in the group of communes with high rate of unhygienic water sources was 1.95 times higher ($p<0.001$) than that in the group with low rate. Also, the rate of stunting malnutrition in the communes with high and average rate of unhygienic water sources was 1.48 times and 2.1 times respectively higher ($p<0.01$-0.001) than that in the group with low rate.

There was no difference in the rate of underweight and stunting malnutrition among the communes with low, average and high rate of households using human excreta composted for less than 6 months.

Figure 3. 15. Odds ratio between the under-5 child nutrition and some related factors at the community level



The figure 3.15 shows that the rate of child underweight and stunting malnutrition in the mountainous rural communes was 1.05-1.53 times higher than that in the delta rural communes ($p<0.01$-0.001).

Only the rate of stunting malnutrition in the poor communes was considerably higher than that in the non-poor communes ($p<0.05$), but the difference in the rate of underweight malnutrition between these two groups was not statistically significant.

The household welfare indicators in this study were analyzed from objective criteria relating to household conditions or living standards. The selected criteria related to the housing

quality included the construction materials of the roof, wall, floor and average housing area per head. The criteria related to hygiene included fuel for cooking, main water source for drinking, who owned the water source, type of latrine, bathroom or bathing facility. The other useful criteria were the assets and durable tools (still in use). The results of analysis show a trend that the rate of stunting and underweight malnutrition declines while the household welfare indicator rises. . However, the rate of stunting and underweight malnutrition in the communes with the lowest household welfare indicators were higher with statistical significance than communes with the highest household welfare indicators ($p<0.001$). The rate of child stunting malnutrition in the communes with average welfare indicators was 1.31 – 2.65 times higher than communes with the highest welfare indicators ($p<0.001$).

The study result did not show a clear relation on stunting malnutrition and underweight malnutrition and the use of fresh human excreta for fertilization.

3.3.1.2 Relation between under-5 child nutrition and some single-variable factors at the household level

Table 3.19. Relation between under-5 child nutrition and some single-variable factors at the household level

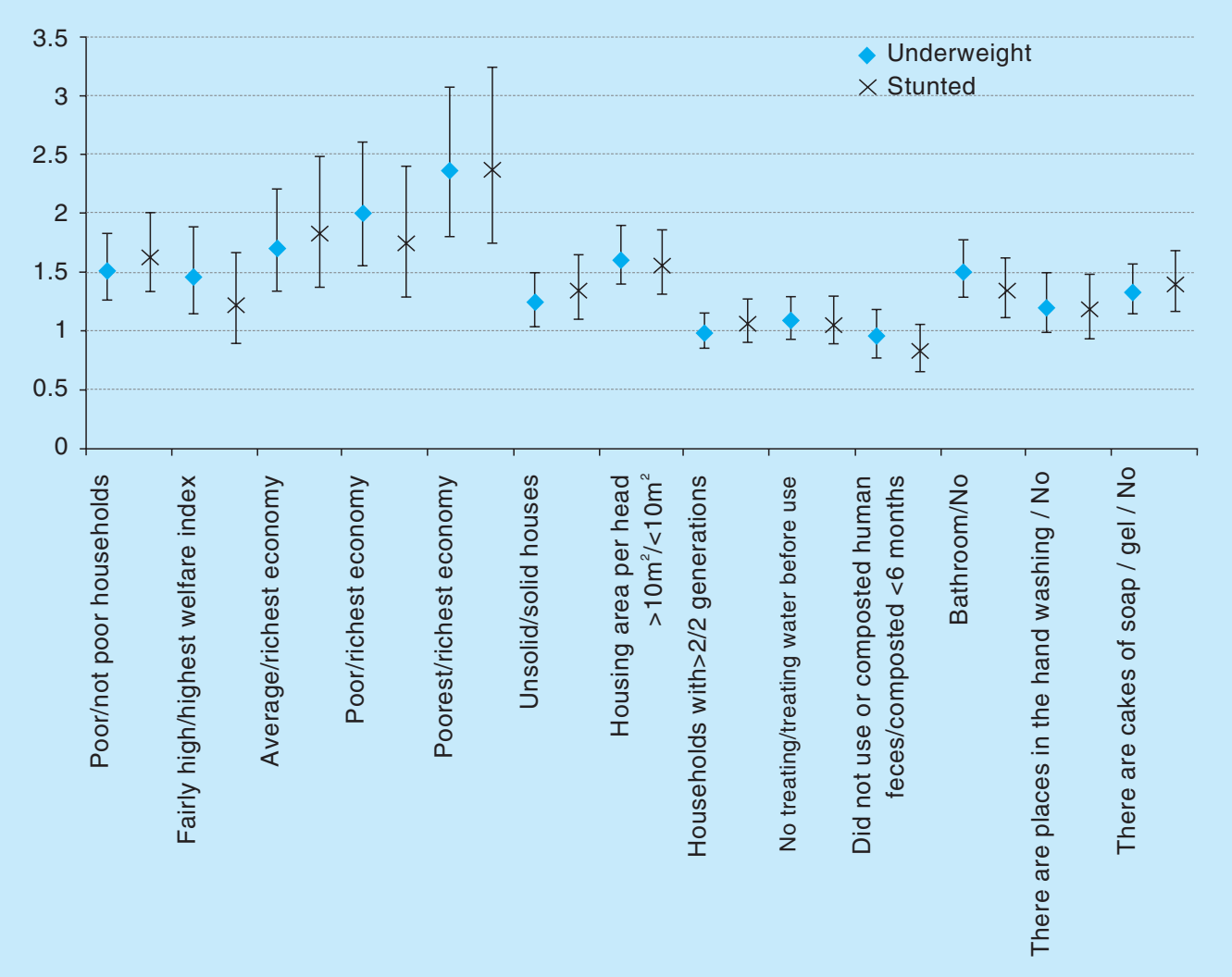
Variable	Underweight malnutrition					Stunting malnutrition				
	Malnourished	Well-nourished	OR	CI 95%	p	Malnourished	Well-nourished	OR	CI 95%	p
Main household water source										
Un-hygienic	119	387	**1.01**	0.76-1.36	0.93	188	318	**1.09**	0.85-1.41	0.49
Hygienic	595	2255	-			1001	1849	-		
Situation of main household water source										
Un-hygienic	346	979	**1.46**	1.22-1.75	0.000	543	782	**1.34**	1.14-1.57	0.00
Hygienic	368	1663	-			646	1385	-		
Pollution risk according to the investigators' observation										
Low risk	368	1663	**1.46**	1.22-1.75	0.00	646	1385	**1.34**	1.14-1.57	0.00
Average-high, very high risk	346	979	-			543	782	-		
Types of surveyed latrines										
Un-hygienic	479	1510	**1.40**	1.15-1.7	0.000	796	1193	**1.27**	1-1.6	0.05
Hygienic	235	1132	-			393	974	-		
Latrines according to the standards of construction and O&M										
Un-hygienic	625	2212	**1.60**	1.29-1.99	0.000	247	744	**1.62**	1.35-1.94	0.00
Hygienic	89	430	-			942	1423	-		
Latrines according to the standard of construction										
Meet the standard	130	616	**1.54**	1.25-1.88	0.000	307	829	**1.50**	1.28-1.77	0.00

Don't meet the standard	584	2026	-			882	1338	-		
Latrines according to the standard of O&M											
Don't meet the standard	144	818	**1.54**	1.25-1.89	0.000	280	808	**1.59**	1.33-1.9	0.00
Meet the standard	570	1824	-			909	1359	-		

The rate of underweight and stunting malnutrition in the families with main un-hygienic water sources for daily activities and drinking was higher than that in the families with main hygienic water sources with statistical significance ($p<0.001$). The rate of underweight and stunting malnutrition in the families with main water sources for daily activities and drinking with average, high and very high pollution risk was significantly higher ($p<0.001$) than that in the families with main water sources with low pollution risk. However, comparison between the families with daily water sources from open ponds/lakes, rivers and the families having one of five types of hygienic water sources (running water, rain water, drilled well water, dug well water, spring head water) shows that there was no significant difference of the rate of child malnutrition; it might be that the percentage of households using pond/lake/river water was so small (15.1%) in comparison with the total of surveyed households.

The rate of underweight and stunting malnutrition in the families without hygienic types of latrines was 1.15-1.70 times higher ($p<0.001$) than those with hygienic types of latrines (septic tank, pour flush, double vault, ventilated improved pit and biogas). The relation was quite close with statistically significance between under-5 child nutritional status and the hygiene situation of latrines according to the investigators' assessment on both construction and O&M standards, which are defined in the Decision No.08/2005/QD-BYT.

Figure 3. 16. Odds ratio between under-5 child malnutrition and some related factors at the household level



Besides the relation with household water supply and latrines, the relation was also shown between the rate of child underweight and stunting malnutrition and some factors such as economic situation, welfare, house condition, availability of bathroom, hand-washing facilities and soap for hand-washing . The relation of each factor is as follows:

- According to the local classification of household economic situation, the rate of underweight and stunting malnutrition in the poor families was 1.25-2.01 times higher than that in the non-poor households ($p<0.001$).

- According to the welfare indicators, the rate of underweight and stunting malnutrition in households with average, low and very low welfare indicators was considerably higher than that of those with the highest welfare indicators ($p<0.001$).

- A concrete, semi- concrete house in this study is defined as one with the floor made of wood / polished wood / rough bricks, cement, sand, crushed bricks; the roof made of metal

sheet / timber / fibro cement / tile / flat roofs; and the walls made of concrete / stone, laterite / red bricks / Papanh brick / non-baked bricks plastered / wood sheet. The survey results show that the rate of underweight and stunting malnutrition in the families without concrete houses was higher than that of underweight and stunting malnutrition with concrete / semi-concrete houses (1.34 and 1.24 times respectively; $p<0.05$).

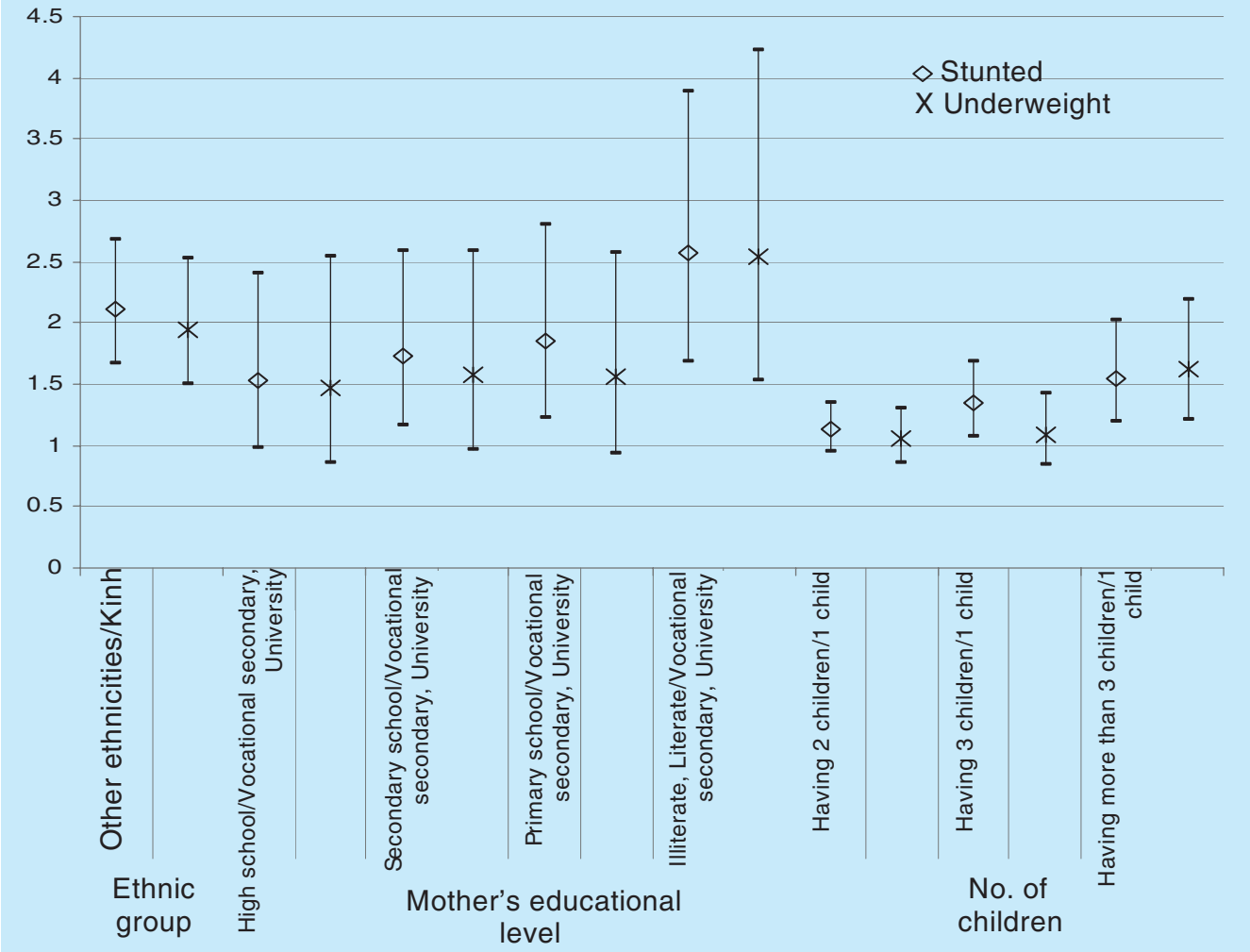
- The rate of underweight and stunting malnutrition in the families with average of total housing area per capita less than $10m^2$ was considerably higher ($p<0.001$) than that in the families with average of total housing area per capita more than$10m^2$. However, it did not show any difference in the rate of malnutrition of children among the families with more than two generations living in one house and those with fewer than two generations living in one house.

- The survey result did not show the close relation between under-5 child malnutrition and their families' application of treating water or not treating water before use. No relation was found between the rate of child malnutrition in the families with the use of untreated feces for fertilization and families without.

- The rate of underweight and stunting malnutrition in the families without bathrooms was considerably higher than that of those with bathrooms ($p<0.001$). The rate of underweight and stunting malnutrition in the families without soap/gel for hand-washing at the survey time was significantly higher than that of those with soap/gel for hand-washing ($p<0.001$). However, it did not show a close relation between under-5 child malnutrition and the households with or without facilities for hand-washing.

3.3.1.3 Relation between under-5 child nutrition and some single-variables at the individual level

Figure 3. 17. The OR between under-5 child malnutrition and some demographic characteristics of child caregivers



At the individual level (the mother/caregiver), the study result shows a close relation between the rate of child underweight and stunting malnutrition and some factors of ethnicity, education, number of children each mother has and personal hygiene behaviors as well as childcare hygiene behaviors. The survey results represent the relation of each factor as follows:

- 34.2% of surveyed main caregivers were ethnic minorities, who took care of 1,148 surveyed children. The rate of child underweight and stunting malnutrition with ethnic minority caregivers was around 2 times higher than that of those with Kinh caregivers ($p<0.001$).

- The lower the mother's education, the higher the rate of child malnutrition was. The

biggest OR was found between the children of illiterate mothers and the children of mothers with at least secondary education. The relation between mothers' education and child stunting malnutrition was more significant than that of underweight malnutrition.

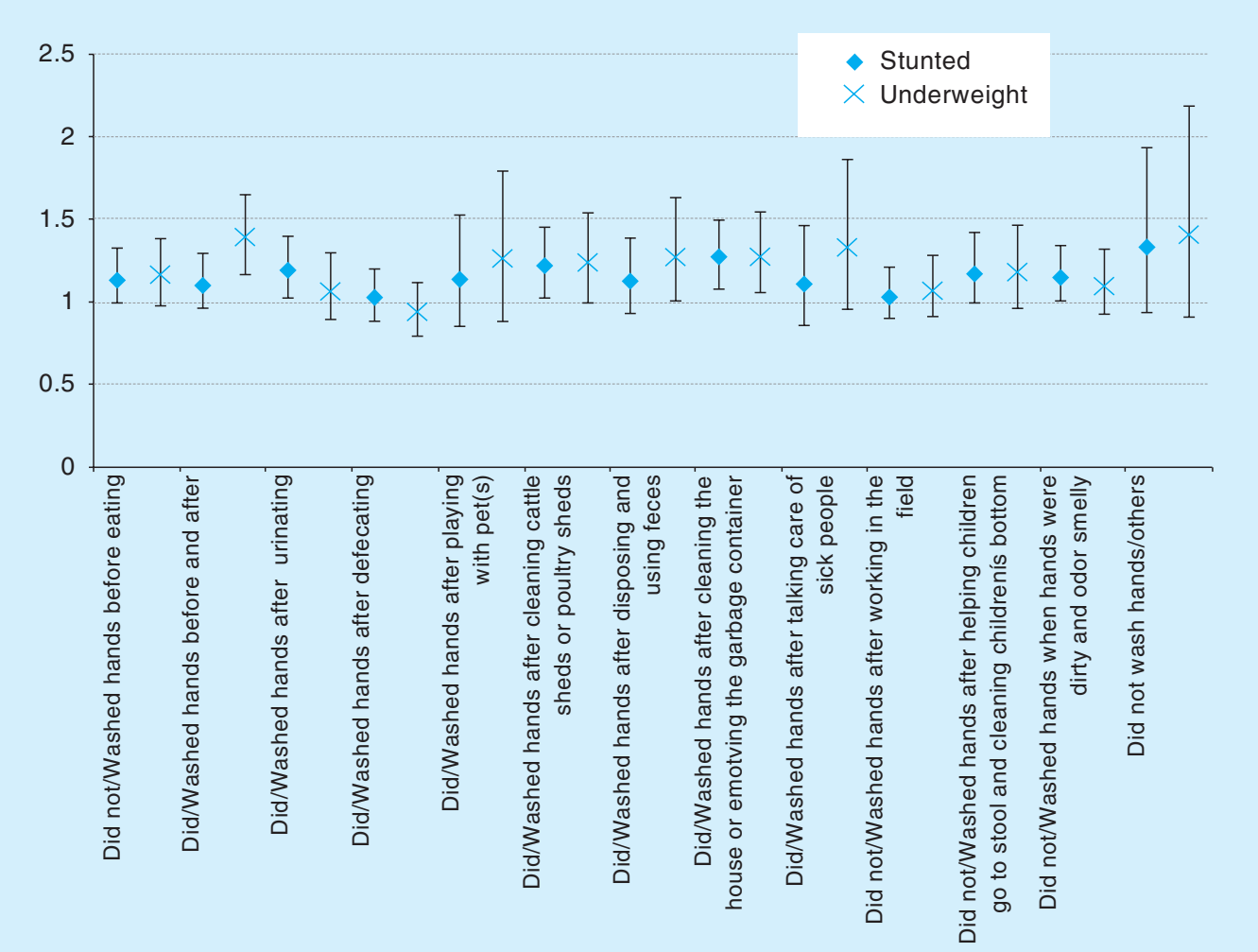
- The rate of underweight and stunting malnutrition in children with mothers with more than 3 children was significantly higher ($p<0.001$) than that of those mothers with only one child. In other words, the more children each mother had, the higher possibility her children became malnourished .

Table 3.20. Relation between the under-5 child nutrition and some single-variables which are hand-washing with water behaviors of caregivers

Variable	Underweight malnutrition					Stunting malnutrition				
	Malnourished	Well-nourished	OR	CI 95%	p	Malnourished	Well-nourished	OR	CI 95%	p
Under 3 behaviors	211	599	**1.31**	1.08-1.58	0.01	337	473	**1.27**	1.08-1.51	0.01
≥ 3 behaviors	503	2043	-			852	1694	-		

The rate of underweight and stunting malnutrition in children of the mothers with hand washing at less than 3 critical times among the behaviors listed in the figure 3.18. was significantly higher ($p<0.05$) than that of those mother with hand washing at 3 or more critical times.

Figure 3. 18. The odds ratio between under-5 child malnutrition and hand-washing behaviors of the mothers



The disparity in the rate of underweight and stunting malnutrition was shown clearly ($p<0.05$) between two pairs of hand washing: washing hands and not washing hands with water only before and after preparing food; washing hands and not washing hands after cleaning the house or after emptying the rubbish container.

The disparity in the rate of child stunting malnutrition was obvious ($p<0.05$) among 3 pairs of hand washing: washing hands and not washing hands with water only after urinating; washing hands and not washing hands after cleaning cattle and poultry cages; washing hands and not washing hands after cleaning the house or after emptying the rubbish.

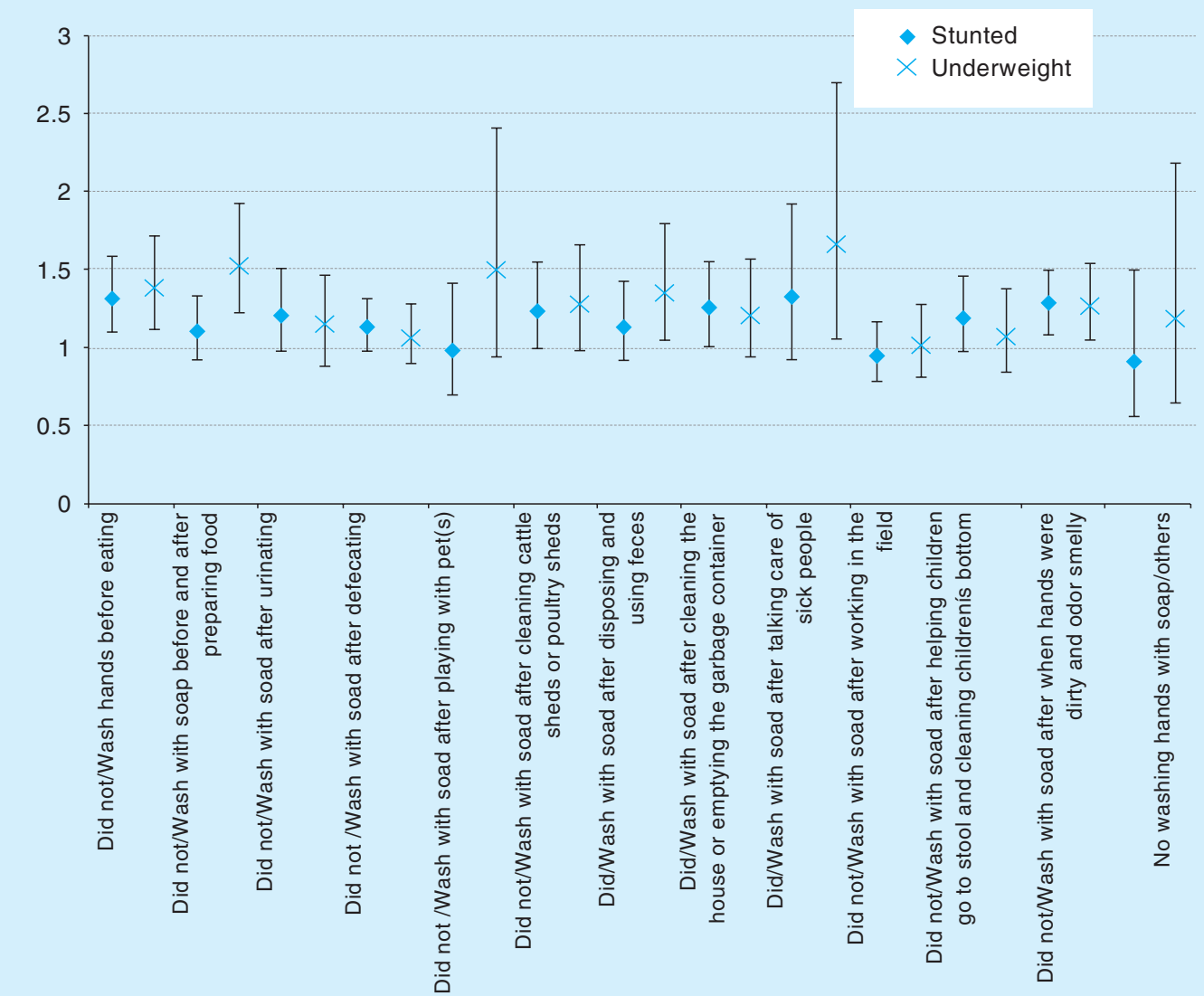
On average, each mother had 7.89/12 hand-washing with water at incorrect times. If the mothers had one more hand-washing behavior at an incorrect time, the risk of underweight malnutrition of their children increased 1.02-1.09 times ($p<0.001$) and/or that of stunting malnutrition 1.02-1.08 times ($p<0.001$).

Table 3.21. Relation between child malnutrition with mothers' hand-washing with soap behaviors

Variable	Underweight malnutrition					Stunting malnutrition				
	Malnourished	Well-nourished	OR	CI 95%	p	Malnourished	Well-nourished	OR	CI 95%	P
< 3 times	509	1653	**1.29**	1.07-1.55	0.01	828	1334	**1.20**	1.02-1.4	0.03
≥ 3 times	205	989	-			361	833	-		

The stunting and underweight malnutrition rates of children of mothers who practiced hand-washing with soap at less than 3 critical times were significantly higher than those of children whose mothers practiced hand-washing with soap at 3 or more critical times ($p<0.05$).

Figure 3. 19. The odds ratio between under-5 child malnutrition with mothers' hand-washing with soap behaviors

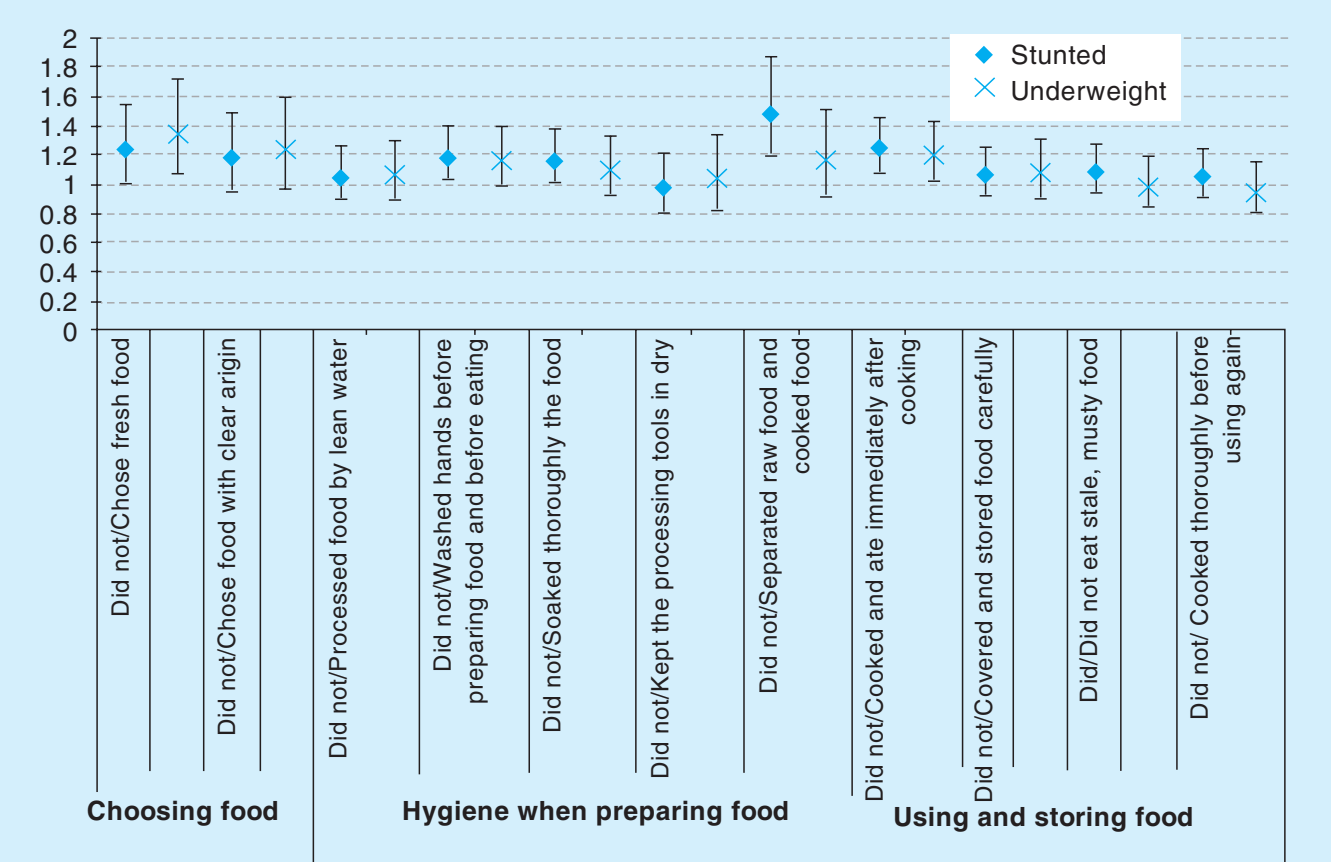


The child underweight malnutrition rate was significantly different (p<0.05) if the mothers practiced or did not practice hand-washing with soap at the 5/12 selected points of time in the study (pairs with OR >1 are shown in the above figure): before eating; before and after preparing food; after disposing and handling feces; after taking care of sick people; when hands were dirty and nasty.

The child stunting malnutrition rate was obviously different (p<0.05) if the mothers practiced or did not practice washing hands with soap before eating and when hands were dirty and smelly.

On average, each mother had 9.94/12 behaviors of washing hands with soap at incorrect times. If the mothers had one more behavior of washing hands with soap at an incorrect time, the risk of underweight malnutrition of their children increased from 1.03 to 1.12 times (p<0.001) and/or that of stunting malnutrition 1.02 to 1.09 times (p<0.001).

Figure 3. 20. The odds ratio between under-5 child malnutrition with mothers' buying, processing and using of food



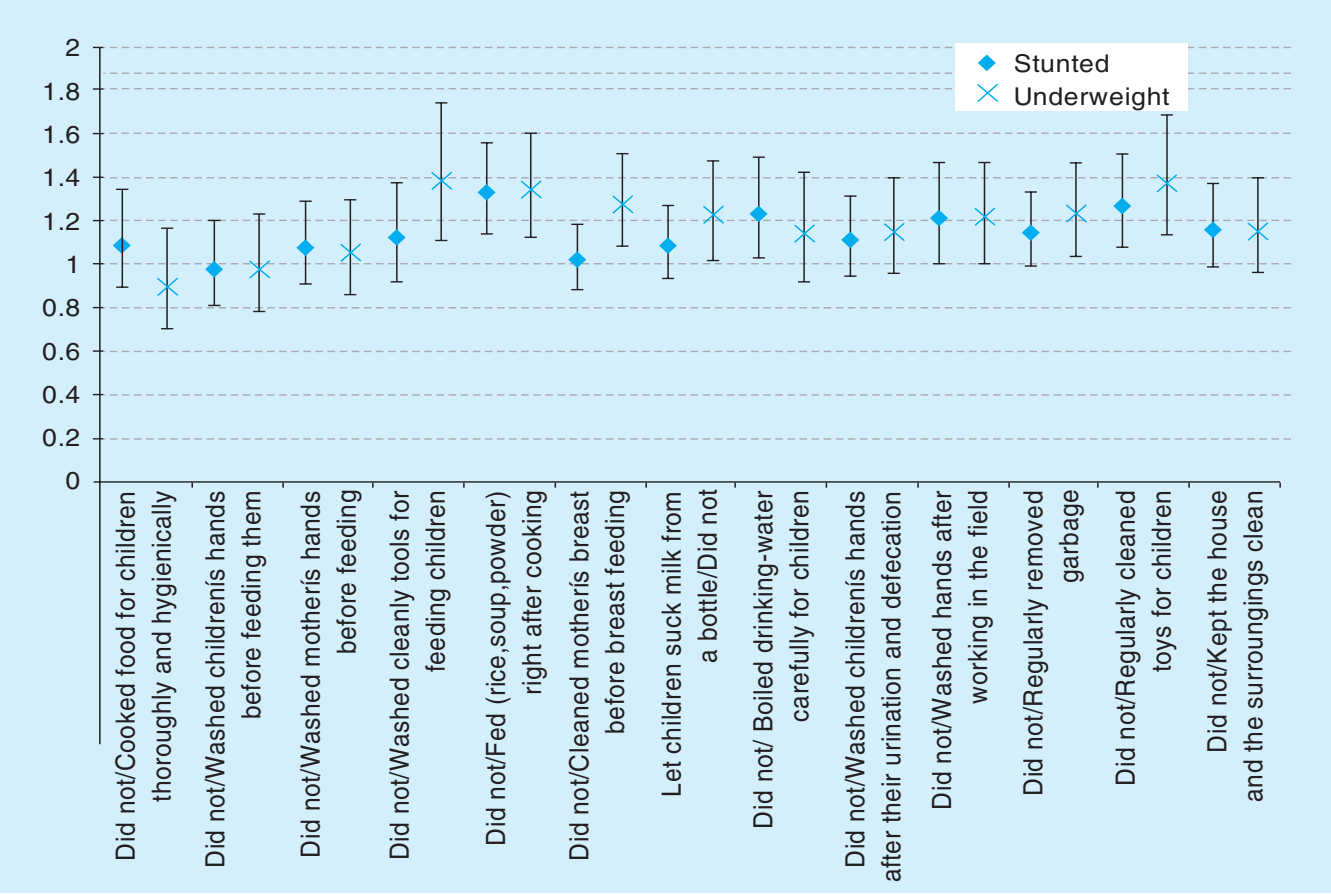
The underweight malnutrition rate in children with mothers who did not buy fresh food for their children was significantly (p<0.05) higher than those with mothers who practiced this behavior. On average, each mother had 1.02/2 incorrect behaviors on buying fresh food. If

the mother had more than one incorrect behavior on buying fresh food, the risk of child malnutrition would increase 1.34 times ($p<0.001$) in the underweight type and/or 1.24 times ($p<0.001$) in the stunting type.

The stunting malnutrition rate was considerably ($p<0.05$) higher in children whose mothers did not wash hands before processing food and before eating, did not thoroughly soak the food, did not carefully wash fruits and vegetables when eating them without cooking, did not keep fresh food and cooked food, used the same processing tools for both cooked food and fresh food, than that in children whose mothers practiced those behaviors. On average, each mother had 1.02/5 incorrect hygiene behaviors of food processing. If mothers had more than one incorrect hygiene behavior of food processing, the risk of child underweight malnutrition increased 1.09 times ($p<0.05$) and/or that of stunting malnutrition increased 1.12 times ($p<0.01$).

The child stunting and underweight malnutrition rates in children whose mothers did not always well cook the food and did not feed them with the food immediately after cooking were considerably higher than those in children whose mothers did ($p<0.05$). On average, each mother had 2.13/4 incorrect behaviors of using and storing food. If a mother had more than one incorrect behaviors of using and storing food, the risk of child stunting malnutrition would increase 1.1 times ($p<0.05$).

Figure 3. 21. The odds ratio between under-5 child malnutrition with mothers' other hygiene behaviors



The child stunting and underweight malnutrition rates were considerably (p<0.05-0.001) higher in children whose mothers did not wash feeding tools properly for children, did not feed their children with rice, soup, porridge right after cooking, did not clean their breast before breast-feeding, did not boil drinking-water carefully for their children, did not wash hands after working in the field, did not regularly remove garbage, and did not regularly clean toys for children, than those in children whose mothers practiced those behaviors.

If mothers had one more unhygienic behavior, the risk of child stunting malnutrition increased 1.01-1.08 times (p<0.05).

3.3.1.4 Relation between under-5 child malnutrition with some direct factors of the children

Table 3.22. Relation between child malnutrition with some direct factors of the children

Variable	Underweight malnutrition					Stunting malnutrition				
	Malno-urished	Well-nourished	OR	CI 95%	p	Malno-urished	Well-nourished	OR	CI 95%	p
Drinking un-boiled water										
Yes	133	379	**1.15**	0.83-1.59	0.41	209	303	**1.62**	1.21-2.18	0.00
No	116	247	-			189	174	-		
Eating salad										
Yes	21	44	**1.13**	0.62-2.03	0.691	33	32	**1.32**	0.77-2.27	0.31
No	157	435	-		2	251	341	-		
Eating un-washed fruits					3					
Yes	36	64	**1.19**	0.72-1.95	0.4505	49	51	**1.25**	0.8-1.96	0.33
No	216	692	-		6	366	542	-		
De-worming during the last 6 months					7 8					
No	301	1209	**1.31**	1.07-1.6	0.01	505	1005	**1.21**	1.02-1.43	0.03
Yes	361	1275	-			617	1019	-		

The stunting malnutrition rate of the children who drank un-boiled water was significantly higher than that of those who did not (p<0.001). There was not a relation between child underweight malnutrition rate and drinking un-boiled water. There were also no relations between child stunting and underweight malnutrition rates and the behavior of eating salad and un-washed fruits.

The child stunting and underweight malnutrition rates of the children who were not provided

with de-worming medicine during the last 6 months were significantly higher than that of those who were ($p<0.05$). Thus, the malnutrition risk of children who had regularly periodic de-worming would be considerably reduced.

3.3.2. Multi-variable logistic regression of risk factors on nutritional status of children under 5

The common statistical methods (linear regression, logistic regression, ANOVA…) are applied with the assumption that phenomena are independent. However, in reality, the phenomena occur similarly in a small population rather than in different populations. For example, children in commune A will have different behaviors from ones in commune B even if they learn in the same school, eat food bought from the same local market, receive health services from the same facility and often have close family relations. This means that the assumption of independence is not true and often leads to inaccurate conclusions. Therefore, data analyzing methods based on the hierarchical structure was often applied as the regression method of GEE (Generalized Estimation Equations). The multi-variable regression method of GEE was also used to define the risk factors related to children under 5 who were under-weight and suffered from stunting malnutrition. To calculate the populationattributable risk (PAR), logistic regression models were performed using only the final model. The outcome variable was the malnutrition status of children under 5. The PAR was used to estimate the proportion of malnourished children under 5 attributable to the selected risk factors. Using the adjusted odds ratio (aOR), the PAR was calculated as follows:

PAR = Proportion of malnourished children under 5 related to the factor $\frac{(aOR-1)}{aOR}$

The PARs for the selected risk factors of the underweight children under 5 are shown in the table below.

Table 3.23. PAR for selected risk factors for underweight children under 5

The study results present that 12% of the total risk for the underweight children under 5

Variable	Prevalence	aOR	PAR	(95% CI)	
Households having hygienic water sources					
High proportion (Ref.)	0.16	1.00	---	---	---
Average proportion	0.20	1.23	0.04	-0.02	0.09
Low proportion	0.24	1.51	0.08	0.02	0.15
Combined risk			0.12	-0.01	0.23
Housing area per head (Over 10 m^2)					
Over 10 m^2/ head (Ref.)	0.17	1.00	---	---	---
<10 m^2 / head	0.23	1.32	0.06	0.02	0.13
Combined risk			0.06	0.02	0.13
Number of children per mother (1 child)					
1 child	0.18	1.00	---	---	---
2 children	0.20	1.01	0.00	-0.04	0.05
3 children	0.19	1.02	0.00	-0.05	0.06
More than 3 children	0.32	1.45	0.10	0.01	0.19
Combined risk			0.10	-0.07	0.27
Hand-washing with soap before and after food preparation					
Yes (Ref.)	0.16	1.00	---	---	---
No	0.21	1.34	0.05	0.01	0.10
Combined risk			0.05	0.01	0.10
Awareness of breast cleaning before breast feeding					
Yes (Ref.)	0.17	1.00	---	---	---
No	0.24	1.22	0.04	0.00	0.07
Combined risk			0.04	0.00	0.07
Child de-worming during last 6 months					
Yes (Ref.)	0.22	1.00	---	---	---
No	0.18	1.24	0.04	0.00	0.06
Combined risk			0.04	0.00	0.06
Certificated as hygienic latrine based on MoH decision no. 08					
Yes (Ref.)	0.15	1.00	---	---	---
No	0.23	1.32	0.06	0.01	0.10
Combined risk			0.06	0.01	0.10

was attributable to the cluster (commune) with a low proportion of households with hygienic water sources. The use of hygienic latrines and housing area per head <10m^2 were also reflected by its moderate PAR (6%). Slightly lower PARs were found in washing hands with soap before and after preparing food (PAR = 5%), not cleaning breast before breast feeding and not de-worming children during the last 6 months (PAR=4%).

Thus, factors of environmental sanitation, water sources and mothers' behaviors such as small housing, unhygienic water sources, having no latrines or unhygienic latrines, not washing hands with soap before and after preparing food, not cleaning the breast before breast-feeding, not de-worming… are directly and closely related to child underweight malnutrition. The table above also shows that incidence of underweight children under 5 could be reduced from 0% to 23% if all households used hygienic water sources. The incidence of underweight children under 5 could be reduced from 1% to 10% if all households used hygienic latrines. The incidence of underweight children under 5 could be reduced from 1% to 10% if all mothers/caregivers washed their hands with soap before and after preparing food for children. And it could be reduced from 2% to 13% if all households increased the housing area per head to more than10m^2, from 0% to 7% if all mothers practiced cleaning breast before nursing their babies; and from 0% to 6% if all children were provided with de-worming medicine once every 6 months.

Table 3.24. PAR for selected risk factors for stunting in children under 5

Variable	Prevalence	aOR	PAR	(95%	CI)
Households with hygienic water sources					
High proportion (Ref.)	0.27	1.00	---	---	---
Average proportion	0.34	1.29	0.08	-0.01	0.16
Low proportion	0.38	1.38	0.11	0.01	0.20
Combined risk			0.17	0.00	0.33
Certificated as hygienic latrine based on MoH statement No. 08					
Yes (Ref.)	0.25	1.00	---	---	---
No	0.37	1.35	0.10	0.04	0.16
Combined risk			0.10	0.04	0.16
Mother's ethnic group (Kinh)					
Kinh (Ref.)	0.30	1.00	---	---	---
Others	0.44	1.53	0.15	0.07	0.24
Combined risk			0.15	0.07	0.24
Number of children per mother (1 child)					
1 child	0.29	1.00	---	---	---
2 children	0.33	1.08	0.03	-0.03	0.09
3 children	0.36	1.30	0.08	0.01	0.16
More than 3 children	0.47	1.29	0.10	-0.01	0.21
Combined risk			0.20	-0.03	0.40
Housing area per head (Over 10 m^2)					
Over 10 m^2/ head (Ref.)	0.28	1.00	---	---	---
<10 m^2 / head	0.38	1.38	0.11	0.06	0.15
Combined risk			0.11	0.06	0.15

Feeding children right after food preparation (Yes)					
Yes (Ref.)	0.31	1.00	---	---	---
No	0.38	1.22	0.07	0.01	0.12
Combined risk			0.07	0.01	0.12

Note:

All values are weighted for the sampling probability

aORs were obtained from a binary logistic regression of the final model with stunting in children under 5, as the outcome variable

Ref: reference group; aOR = adjusted Odds Ratio

The results show that 17% of the total risk for stunting in children under 5 was attributable to the cluster (commune) with a low proportion of households with hygienic water sources. The use of unhygienic latrines also contributed a significant part of PAR (PAR=10%). Ethnicity also accounted for a significant rate (PAR=15%). The housing area per head less than 10m^2 was found at a lower rate (PAR=11%). The behavior of not feeding children right after preparing food also contributed to the risk of stunting in children under 5 (PAR=7%).

Thus, similar to underweight malnutrition, factors of environmental sanitation, water sources and mothers' behaviors such as small housing, unhygienic water sources, no latrines or unhygienic latrines, not feeding children immediately after cooking and ethnicity (ethnicity, in fact, is somehow reflecting difficult access to hygienic water sources and hygienic latrines, and poor hygiene behaviors on child care) are also directly and closely related to child stunting malnutrition (prolonged malnutrition). The incidence of stunting in children under 5 could be reduced from 0% to 33% if all households used increasing the rate of households using hygienic water sources. It could be reduced from 4% to 16% if all households using used hygienic household latrines. And it could be reduced from 6% to 15% if all households increased the housing area per head to more than10m^2.

By calculating the population attributable risk (PAR), it can be concluded with 95% confidence interval that: i) the rates of underweight and stunting among children under 5 could be reduced by 0-23% and 0-33% respectively if all households used hygienic water sources; ii) the rates of underweight and stunting among children under 5 could be reduced by 1-10% and 4-16% respectively if all households used of hygienic latrines; iii) the rate of underweight among children under 5 could be reduced by 1-10% if all mothers/caregivers practiced hand washing with soap before and after preparing food for children; iv) the rate of underweight among children under 5 could be reduced by 0-7% if all mothers practiced cleaning breast before nursing the babies v) the rate of underweight among children under

5 could be reduced by 0-6% if all children were provided with deworming medicine every 6 months.

The contribution of variables to the model means the contribution of variables put into the model when compared with contribution of all the variables in the logistic regression model to estimate the value of the dependent variable (malnutrition). The higher percentage a variable contributed, the stronger that variable can influence the dependent variable.

Table 3.25. Contribution rate of variables in the multi-variable logistic regression model (%)

Multi-variable logistic regression model	Contribution rate	
	Total of the model	Apart from the basic variables (age, gender)
Logistic regression model (underweight)		
Basic variables (age, gender)	26.57%	100.00%
Children did not have de-worming during the last 6 months	59.33%	80.80%
Total housing area per capita was <10m2	4.60%	6.27%
Communes had a low coverage of households with hygienic water sources	3.60%	4.90%
Mothers did not wash hands with soap before and after preparing food	1.80%	2.45%
Mothers had total of more than 3 children	1.68%	2.29%
Latrines did not meet the MOH standards defined in the Decision 08/2005/QD-BYT	1.33%	1.80%
Mothers did not clean their breast before breast-feeding	1.09%	1.48%
Logistic regression model (stunting)		
Basic variables (age, gender)	63.63%	100.00%
Communes had a low coverage of households with hygienic water sources	8.42%	23.15%
Latrines did not meet the MOH standards defined in the Decision 08/2005/QD-BYT	8.18%	22.48%
Ethnic minority	6.78%	18.63%
Total housing area per capita was <10m2	6.48%	17.82%
Mothers had total of more than 3 children	4.31%	11.85%
Mothers did not feed child immediately after cooking	2.21%	6.08%

In the logistic regression model for underweight malnutrition analysis, apart from the basic variables (age, gender), the variable that influenced the most on the child stunting malnutrition rate was no de-worming during the last 6 months. The other risk factors ranging from high to low were: the total housing area per capita was less than 10m^2, the low coverage of households with hygienic water sources, the mothers without washing hands with soap before and after preparing food for their children, mothers with more than 3 children, households with latrines not meeting the MOH standards in the Decision 08/2005/QD-BYT; and mothers without cleaning their breast before breast-feeding.

In the logistic regression model for stunting malnutrition analysis, apart from the basic variables (age, gender), the variable that influenced the most on the child stunting malnutrition rate was the low coverage of households with hygienic water sources. The other risk factors arranged from high to low respectively were: the households with latrines not meeting MOH standards according to the Decision 08/2005/QD-BYT; the non-Kinh children; the total housing area per capita less than 10m^2; mothers with more than 3 children; mothers who did not feed children immediately after cooking.

Thus, besides the economic and ethnic factors, the sanitary factors were main causes of child malnutrition. The sanitary factors were no de-worming for children, unhygienic water source, using unhygienic latrines, having no latrines, improper disposal of children's feces, no washing hands with soap before and after preparing food… Indeed, having no latrines or having latrines which could not isolate and properly dispose human feces were the main cause of microbiologic pollution of water for cooking and drinking as well as pollution of soil, food, hands and other parts of the body… Thus, if the isolation and safe disposal of human waste was properly done, soil, water source, and food would be cleaner; it also means that the rate of malnutrition in children would be reduced.

Based on the logistic regression model, it could be estimated that the child malnutrition rate and water and hygienic factors have very close relations.

Table 3.26. Estimation of the underweight malnutrition rate

Logistic regression model (underweight malnutrition)	The lowest risk	The highest risk	Disparity
Commune groups by rate of households with unhygienic water source	16%	23%	6%
Total number of children	18%	25%	6%
Total housing area per capita	17%	21%	4%
Not washing hands with soap before and after preparing food	16%	20%	4%
Latrines did not meet the MOH standards defined in the Decision 08/2005/QD-BYT	16%	20%	4%
Mothers did not clean their breast before breast-feeding	18%	21%	3%
Children not de-wormed during the last 6 months	18%	21%	3%

Estimation of the underweight malnutrition rate based on the logistic regression model shows that the rate would be 16% if most households in communes use hygienic water sources, and the rate could increase by 6% up to 23% if most households in communes used unhygienic water sources with the condition that other variables were constant and equal to the average value in the sample.

Similarly, the disparity in the underweight malnutrition rate between families having one child and more than three children was about 6% between families having total housing area per capita more than 10m^2 and ones less than10m^2 about 4%; between mothers washing hands with soap before and after preparing food and those that did not about 4%; between households using hygienic latrines and households without hygienic latrines also about 4%; between mothers cleaning their breast before breast-feeding and mothers who did not about 3%; and between children who were de-wormed during the last 6 months and children who were not also about 3%.

Table 3.27. Estimation of the stunting malnutrition rate

Logistic regression model (underweight malnutrition)	The lowest risk	The highest risk	Disparity
Commune groups by rate of households with unhygienic water source	16%	23%	6%
Total number of children	18%	25%	6%
Total housing area per capita	17%	21%	4%
Not washing hands with soap before and after preparing food	16%	20%	4%
Latrines did not meet the MOH standards defined in the Decision 08/2005/QD-BYT	16%	20%	4%
Mothers did not clean their breast before breast-feeding	18%	21%	3%
Children not de-wormed during the last 6 months	18%	21%	3%

The stunting malnutrition rate was 31% if children were Kinh ethnicity and could increase by 10% up to 40% if children were in ethnic minorities; the condition was that other variables were constant equal to the average value in the sample.

The disparity in the stunting malnutrition rate between commune groups with families having hygienic water sources or very few with unhygienic water sources and communes with most families using unhygienic water sources was about 7%; between households using hygienic latrines and households without hygienic latrines about 7%; between households having total housing area per capita more than 10m^2 and ones less than10m^2 also about 7%; between families having one child and more than three children about 6%; and between mothers feeding children immediately after cooking and mothers who did not about 5%.

The estimations above show that to reduce the child malnutrition rate remarkably and stably we should solve absolutely the disposal of human feces: all people have to defecate in hygienic latrines in order to avoid feces contamination into water sources, soil, food and hands. For most families, it is necessary to have good communication propaganda; however, it must be ideal for very poor families, if social protection program applied to provide them with financial support or loans without interest, with low interest or conditional cash transfer for hygienic latrine construction and use because one cheapest latrine costs at least one million VND while the poverty line defined by the Ministry of Labor, Invalid and Social Affairs (MOLISA) is approximately VND300.000.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusion

4.1.1. Child malnutrition rates in the six provinces covered by the study were higher than the national averages and there are differences between underweight and stunting rates, as well as disparities between different geographic locations:

In the six provinces, the under-5 child stunting rate was 35.4% (CI of 95%, 30,7%-36,2%) and the underweight 21.3% (CI of 95%, 18,2%-22,3%) while the national rates were 31.9% and 18.9% respectively. Both the stunting and under-weight rates were highest in Kon Tum province (46.4% with CI of 95%, 38.9-54.2%, and 27.8% with CI of 95%, 20.2-37%) and lowest in Nam Dinh province (23.9% with CI of 95%, 19.3-28.8% and 14.9% with CI of 95%, 11-19.8%).

The child stunting and under-weight rates increased in proportion to the increase in age among children in the age cohorts of over one year.

The child stunting and underweight rates among Kinh children (stunting: at 95% CI, 26.5-32.6%, underweight: at 95% CI, 16.0-20.2%) were significantly lower than those of ethnic minority children (stunting: at 95% CI, 39.3-49.7%, underweight: at 95% CI, 21.9-31.4%). The child malnutrition rates in the poor families (stunting : at 95% CI, 40.1-51.5%, underweight: at 95% CI, 24.2-33.3%) were higher than those in the non-poor families (stunting: at 95% CI, 27.4-33.1%, underweight : at 95% CI, 16.1-20.1%) . The child malnutrition rates in mountainous areas were higher than those in plain areas (stunting: 43,4% vs. 25,5% and underweight: 29,6% vs. 18,2%)..

The child stunting and under-weight rates are inversely proportional to the mothers' education level and directly proportional to the number of children. .

4.1.2. Rates of households with improved water supply, household hygienic latrines and soap availability were unevenly distributed among the studied provinces:

15.1% of the studied households were still using water from rivers, streams/lakes as the main water source for cooking, drinking and other purposes; 30.4% of the households were using unhygienic water sources, 4.6% and 15.3% of household water sources were at high and very high risks of contamination respectively. The proportion of households using water sources with high and very high risks of contamination was highest in An Giang (54.1%) and lowest in Ha Tinh (3.6%).

Only 59% of the households had soap/gel at the hand washing facilities. The rate of households with soap at hand washing facilities was found to be the lowest in Dien Bien (29.1%) and the highest in Nam Dinh (84.5%).

The rate of households with latrines meeting all the standards defined in the Decision 08/2005/QD-BYT was only 30.9%. Dien Bien and Kon Tum had the lowest rates of households with hygienic latrines at 4.3% and10.2% respectively.

4.1.3. Many studied mothers lacked knowledge of and did not practice personal hygiene behaviors and hygiene behaviors for child care properly:

23.8% of mothers reported “sometimes” washing hands. Only 36.2% of mothers often washed hands with soap after defecating, 22.8% before eating, 19% before and after preparing food, and 14.9% after helping children go to stool and cleaning children’s bottom.

41.2% of mothers did not correctly treat/dispose of children’s excreta; they mostly used it as “food for dogs or pigs” (21.1%), or used to “throw it to the garden” (16.3%), “throw it to the field or rivers” (13.6%).

Some important behaviors, which mothers/caregivers need to practice in processing food for families, were not mentioned by them such as washing hands before preparing food and before eating (36.4%), carefully cleaning food and washing fruits, salad and vegetables (38.9%), uncooked food to be kept separate from cooked food (13.8%) for their children.

4.1.4. There were negative relations between the nutritional status of children under-5 and following factors:

At the community level: geographical condition (in the rural mountainous and in the rural delta communes), commune economic status and social welfare index; and proportion of household with hygienic latrines;

At the household level: housing conditions including water source, latrine, bathroom, and hand washing facility and soap for washing hands;

For the mothers/main caregivers: the ethnicity, education level, mother’s number of children and mothers’ personal hygiene behaviors including hygiene behaviors for child care.

4.1.5. Following factors influenced child nutritional status the most as found in the multi-variable logistic regression analysis:

At the household level: children living in cramped houses, without latrines or with unhygienic latrines, and using unhygienic water sources.

The mothers or main caregivers: poor hygiene practices such as not washing hands with soap before and after preparing food for children, not cleaning their breast before breast-feeding babies.

4.1.6. By calculating the population attributable risk (PAR), it can be concluded with 95% confidence interval that:

The rates of underweight and stunting among children under 5 could be reduced by 0-23% and 0-33% respectively if all households used hygienic water sources;

The rates of underweight and stunting among children under 5 could be reduced by 1-10% and 4-16% respectively if all households used of hygienic latrines;

The rate of underweight among children under 5 could be reduced by 1-10% if all mothers/caregivers practiced hand washing with soap before and after preparing food for children.

4.2. Recommendations

Policy:

The National Targeted Program of Rural Water Supply and Sanitation with a focus on improving environmental sanitation and water quality through better treatment/disposal of human excreta and waste should be continued. Investments should be prioritized to remote/disadvantaged areas and to the areas with low coverage of hygienic sanitation and clean water supply.

Water, sanitation and hygiene should be an integral part of any new child nutrition policy/strategy or action plans and vice versa for policy advocacy and behavioral change communication.

A comprehensive sanitation action plan with a clear road map to achieve 100% coverage of households with hygienic latrines should be developed for more effective implementation of sanitation component in the new phase of the National Targeted Program of Rural Water Supply and Sanitation.

Government should financially support very poor families with malnourished children to enable them to construct hygienic latrines for their households with particular focus on ethnic minority areas.

Policies should focus on the promotion and support to sanitation marketing for hygienic latrine construction, especially in remote areas, to meet the demand for latrines.

Intervention:

Implementation and scaling up of effective models for hygiene promotion and water quality improvement such as Community Led Total Sanitation, Intensive Sanitation Promotion, linking them with child nutrition, to rapidly and sustainably increase coverage and use of hygienic latrines, should be continued;

Sanitation marketing approach to support hygiene promotion models, which are culturally,

technologically and financially appropriate to different geographic areas, should be developed; Consultation support to households on geographically and financially appropriate selection of latrine models for construction and on proper use and maintenance of the constructed latrines, should be a part of sanitation marketing.

Quality of behavioral change communication to raise community's demand for personal hygiene, household environmental sanitation, and improved water quality needs further improvements. IEC activities targeting mothers/caregivers should focus on key messages of WASH (use and protection of household water supply sources, proper use of hygienic latrines, hand-washing with soap and other child- care hygiene behaviors).

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ANNEX: LIST OF THE 72 COMMUNES IN THE 6 STUDIED PROVINCES

Province	No.	District	Code	Commune
Dien Bien	1	*Muong Cha*	03196	Huoi Leng
	2		03197	Sa Long
	3		03200	Ma Thi Ho
	4	*Tuan Giao*	03271	Pu Nhung
	5		03274	Quai Nua
	6		03289	Quai Cang
	7	*Dien Bien*	03319	Muong Pon
	8		03325	Muong Phang
	9		03334	Thanh Xuong
	10		03346	Thanh Yen
	11		03352	Noong Het
	12		03358	Nua Ngam
Nam Dinh	1	*Y Yen*	13807	Yen Loi
	2		13816	Yen Minh
	3		13867	Yen Phuc
	4	*Nghia Hung*	13900	Nghia Thinh
	5		13906	Nghia Thai
	6		13918	Nghia Son
	7	*Xuan Truong*	14107	Xuan Dai
	8		14122	Xuan Phuong
	9		14143	Xuan Ninh
	10	*Hai Hau*	14227	Hai Trung
	11		14239	Hai Hung
	12		14266	Hai Quang
Ha Tinh	1	*Duc Tho*	18256	Duc Nhan
	2		18259	Tung Anh
	3		18286	Duc Lam
	4	*Can Loc*	18415	Thien Loc
	5		18427	Vuong Loc
	6		18445	Tung Loc

Province	No.	District	Code	Commune
	7	*Thach Ha*	18601	Phu Viet
	8		18628	Tuong Son
	9		18643	Thach Dai
	10	*Ky Anh*	18769	Ky Tien
	11		18814	Ky Tan
	12		18820	Ky Trinh
Ninh Thuan	1	*Ninh Son*	22813	Lam Son
	2		22822	My Son
	3		22828	Ma Noi
	4		22831	Nhon Son
	5	*Ninh Hai*	22858	Xuan Hai
	6		22861	Ho Hai
	7		22864	Tri Hai
	8		22868	Thanh Hai
	9	*Ninh Phuoc*	22879	Phuoc Hau
	10		22882	Phuoc Thuan
	11		22885	Phuoc Ha
	12		22888	An Hai
Kon Tum	1	*Kon Tum town*	23320	Vinh Quang
	2		23323	Dak Bla
	3		23329	Doan Ket
	4		23335	Dak Ro Wa
	5		23338	Hoa Binh
	6	*Dak Glei*	23353	Dak Pek
	7		23374	Dak Mon
	8	*Ngoc Hoi*	23389	Dak Xu
	9		23395	Po Y
	10	*Dak Ha*	23506	Dak HRing
	11		23509	Dak Ui
	12		23512	Dak Mar

Province	No.	District	Code	Commune
An Giang	1	*Tan Chau*	30379	Phu Loc
	2		30391	Long An
	3	*Chau Phu*	30469	My Duc
	4		30478	Vinh Thanh Trung
	5		30496	Binh Phu
	6	*Chau Thanh*	30604	Vinh Binh
	7		30607	Binh Hoa
	8	*Cho Moi*	30637	My Hoi Dong
	9		30649	Kien Thanh
	10		30652	My Hiep
	11		30670	An Thanh Trung
	12		30673	Hoi An

DATA COLLECTION FORM FOR HOUSEHOLDS

Part 1. Secondary information

Information extracted from the Institute of Nutrition's data collection forms conducted at 30 sites

Province:..... District:……..……..

Commune:..... Hamlet/village:……..…..……..

Number	Full name	Gender	Date of birth
Child 1			
Child 2			
Child 3			
Mother			

Full name of the survey subject:.....Tel/mobile phone:……..……..

Full name of investigator:.....Signature:.....

Date of interview:...../...../2009

If it is impossible to find/interview a subject, it is because (of):.....

Part 2. Interview and observation

No.	Question	Answer	
General information			
C1.	In which year were you born?		
C2.	Gender of interviewee	1. Male 2. Female	
C3.	What is your relation with the child?	1. Father/Mother 2. Sibling	3. Grandfather/Grandmother 4. Other (specify:.....)
C4.	What is your main job?	1. Farmer 2. Worker 3. White collar worker	4. Trader 5. Housewife 6. Other (specify:.....)
C5.	To what ethnic group do you belong?	1. Kinh 2. Tay 3. Thai 4. H'Mong 5. Dao	6. Gia Rai 7. Ba Na 8. E de 9. Muong 10. Other (specify:.....)
C6.	What is your educational level?	1. Illiterate 2. Only knowing how to read and write 3. Primary school	4. Secondary school 5. High school 6. Secondary technical school, college, university or higher

No.	Question	Answer	
C7.	How many children do the child's parents have?	……. Child/children	
C8.	How many members are there in the child's family?	……..person(s)	
C9.	How many generations are there in the child's family?	1. Two	2. Three or more
C10.	How is the child's family's financial condition?	1. Poor	2. Non-poor
Housing condition			
C11.	What is the main material for building floors? (Combined with observation)	1. Ground floor 2. Plywood, bamboo, palm 3. Wood floor, polished wood 4. Mud brick, cement, mortar, broken brick 5. Ceramic tiles, marble, porcelain tiles 6. Other (specified:……..)	
C12.	What is the main material for roofing? (Combined with observation)	1. Leaves, straws 2. Bamboo stem, tree trunk 3. Oil paper 4. Mental roof	5. Wood 6. Fibre cement 7. Tiles 8. Flat roofs/flat reinforced concrete roofs 9. Other (specify:.....)
C13.	What is the main material for building walls? (Combined with observation)	1. No wall 2. Reed, palm, tree trunk 3. Mortared earth wall 4. Plywood board, carton boards, recycled wood (packaging wood) 5. Concrete wall 6. Stone, laterite 7. Mortared baked bricks 8. Papanh brick, (slag brick) 9. Mortared nonbaked bricks 10. Plywood/laminated wood board, veneer 11. Other (specify:.....)	
C14.	What is the total living area? (Observation combined)	_ _ _ _ m^2	
C15.	Is there a bathroom available in your house? (Observation combined)	1. Yes 2. No	
C16.	Do you have a/an […]? (Multiple-choice question . Mark one or more options if the interviewed family reports that the appliance or device is	1. Black-and-white TV 2. Colour TV 3. Video player/DVD player 4. Digital player 5. DTH satellite head-end	10. Computer 11. Fridge/Freezer 12. Air-conditioner 13. Washing machine 14. Electric heater 15. Bicycle

No.	Question	Answer	
	in a good condition)	device 6. Stereo system 7. Radio cassette 8. Telephone 9. Mobile phone	16. Motorbike 17. Boat/canoe 18. Car
C17.	What is the main source of fuel that you use for cooking?	1. Electricity 2. Bottled liquid gas 3. Biogas 4. Kerosene 5. Peat, coal, firewood, charcoal 6. Wood, straw, leaves, hay 7. Other (specify: ……..)	
THE STATUS OF WATER SOURCES AND THE USE OF DAILY LIVING WATER			
C18.	What are your main sources of water for eating, drinking and daily living? (Combined with observation)	1. Tap water 2. Rain water 3. Dug well water	4. Drilled well water 5. Protected tube well water 6. River water, stream water, lake water, pond water 7. Other (specify:.....)
C19.	To whom does that/those main water source(s) belong?	1. Public 2. Your family	3. Neighbor 4. Other (specify:.....)
C20.	Is that main water source sufficient for use?	1. Plentiful 2. Sufficient 3. Sufficient if saved 4. insufficient	
C21.	If water becomes scarce/insufficient , then in which season? For how many months?	Season: …… No. of months:……	
C22.	Do you think the water source you are using is hygienic? (transparent, odorless, and having no unpleasant taste that irritates water users) (Combined with observation)	1. Hygienic 2. Unhygienic 3. Do not know/ do not answer	
Assessment of the sanitary status of water sources (investigators use checklists of observation of main water sources at the households in which the scoring method is applied in order to identify the pollution risk of water sources: if the score is less than 3, the risk is considered at a low level; from 3-5, at a medium level; from 6-7, at a high level; and from 8-9, at a very high level).			
C23.	Dug well water (Use Checklist 6)	1. Low risk 2. Medium risk 3. High risk 4. Very high risk	
C24.	Drilled well water	1. Low risk	

No.	Question	Answer
	(Use Checklist 7)	2. Medium risk 3. High risk 4. Very high risk
C25.	Rain water ***(Use Checklist 8)***	1. Low risk 2. Medium risk 3. High risk 4. Very high risk
C26.	Tube well water ***(Use Checklist 9)***	1. Low risk 2. Medium risk 3. High risk 4. Very high risk
C27.	Do you treat water before you use it?	1. Yes 2. No → **Skip to C29**
C28.	How do you treat water before you use it for eating, drinking and daily living? ***(Because this is a multiple-choice question, investigators combine reading and observation)***	1. Natural sedimentation 2. Alum sedimentation 3. Use a rainwater collection system 4. Use filter tank 5. Sterilize water with chloramines 6. Use a sterilizing filter device 7. Other (specify:.....) 8. Do not know/be unaware
C29.	Is any other water source used apart from the main ones used for eating, drinking and daily living?	1. Yes 2. No → **skip to C32**
C30.	If yes, what source of water is that? ***(Combined with observation, circle only one option)***	1. Tap water 2. Rain water 3. Dug well water 4. Drilled well water 5. Protected tube well water 6. River, stream, pond and lake water 7. Other (specify:.....)
C31.	Is the water source that your family are **using besides the main ones** considered hygienic, according to your sensory assessment *(transparent, odorless, colorless, having an unpleasant taste that irritates users)*? ***(Combined with observation)***	1. Hygienic 2. Unhygienic 3. Do not know / Do not answer
C32.	Do floods or droughts annually strike/sweep through your area?	1. Yes, flood only 2. Yes, drought only 3. Yes, both flood and drought 4. No → **Skip to C36**

No.	Question	Answer	
C33.	Do floods or droughts affect the quality of water sources for eating, drinking and daily living?	1. Yes 2. No → **Skip to C36**	
C34.	If yes, which source of water do you use for eating, drinking and daily living when a flood or drought occurs? ***(Multiple-choice question)***	1. Tap water 2. Rain water 3. Dug well water 4. Drilled well water	5. Protected tube well water 6. River, stream, pond or lake water 7. Buy/ Bring home from other places 8. Other (specify:.....)
C35.	Which measure do you use to treat that water source before using it for eating, drinking and daily living? ***(Multiple-choice question)***	1. Natural sedimentation 2. Alum sedimentation 3. Use a rainwater collection system 4. Use filter tank 5. Sterilize water with Chloramines 6. Use a sterilizing filter device 7. Other (specify:.....) 8. Do not know/ unaware 9. No treatment	
C36.	Where does the water source used for eating, drinking and daily living come from? ***(investigators observation, multiple-choice question)***	1. Tap inside the house 2. Tap outside the house 3. Draw/scoop/pump from a well 4. Scoop from a bucket/water tank 5. Other (specify:.....)	
C37.	How far is it from the tap outside – the water source used for eating, drinking and daily living – to your house?	1. Less than 5 m 2. 5 - 10 m 3. >10 m	
C38.	How far is it from the hand-washing amenity to the latrine?	1. Less than 5 m 2. 5 - 10 m 3. >10 m	
HOUSEHOLD LATRINE – THE USE OF HUMAN FECES IN CULTIVATION			
C39.	Does your family have a latrine?	1. Yes 2. No → ***Skip to C46***	
C40.	If yes, which type of latrine is it? ***(Combined with observation)***	1. Septic tank 2. Double vault → ***Skip to C42*** 3. Ventilated improved pit → ***Skip to C43*** 4. Pour flush → ***Skip to C44*** 5. Biogas → ***Skip to C45*** 6. Other (specify:.....) → ***Skip to C46***	

No.	Question	Answer
C41.	The hygiene situation of the construction, operation and maintenance of septic tank latrines ***(Use check list 1)***	1. Meeting hygiene standards of construction 2. Meeting hygiene standards of operation and maintenance 3. Not meeting hygiene standards of construction, operation & maintenance
C42.	The hygiene situation of the construction, operation and maintenance of double vault latrines ***(Use check list 2)***	1. Meeting hygiene standards of construction 2. Meeting hygiene standards of operation and maintenance 3. Not meeting hygiene standards of construction, operation & maintenance
C43.	The hygiene situation of the construction, operation and maintenance of ventilated pit latrines ***(Use check list 3)***	1. Meeting hygiene standards of construction 2. Meeting hygiene standards of operation and maintenance 3. Not meeting hygiene standards of construction, operation & maintenance
C44.	The hygiene situation of the construction, operation and maintenance of pour flush latrines ***(Use check list 4)***	1. Meeting hygiene standards of construction 2. Meeting hygiene standards of operation and maintenance 3. Not meeting hygiene standards of construction, operation & maintenance
C45.	The hygiene situation of construction, operation and maintenance of biogas latrines ***(Use check list 5)***	1. Meeting hygiene standards of construction 2. Meeting hygiene standards of operation and maintenance 3. Not meeting hygiene standards of construction, operation & maintenance
C46.	Does your family use human feces in agricultural production? ***(Multiple-choice question)***	1. Yes, for fertilization 2. Yes, for feeding fish 3. Other (specify:.....) 4. No → ***Skip to C49***
C47.	Does your family use treated or untreated human feces in agricultural production?	1. Treated human feces 2. Untreated human feces → ***Skip to C49***
C48.	For how many months do you compost human feces?	1. 6 months or more 2. less than 6 months 3. Do not know/ Do not remember 4. Other (specify:.....)
C49.	How do you deal with children's feces? ***(Multiple-choice question)***	1. Dispose of it in latrines 2. Bury it in gardens/yards 3. Dispose of it in garbage containers 4. Dispose of it in yards 5. Dispose of it in garden 6. Dispose of it in fields/rivers, streams, etc. 7. Use as food for dogs/pigs 8. Other (specify:.....)

No.	Question	Answer		
C50.	Does your family have a hand-washing place? ***(Combined with observation)***	1. Yes 2. No		
C51.	Does your family have soap for washing hands (gel or bar)? ***(Combined with observation)***	1. Yes 2. No → Skip to C53		
C52.	If yes, where do you put the soap? ***(Multiple-choice question)***	1. Near the latrine (<5m) 2. Near the hand-washing amenity(<5m) 3. Other (specify: ……..……)		
C53.	What is the main reason why your family does not have soap for washing hands? (bar soap/gel)?	1. the old one is just used up and the new has not been bought 2. Forget to buy a new one 3. Do not have enough money to buy one 4. Do not use because soap it is expensive 5. Do not have a habit of using soap 6. Other (specify:.....)		
THE HYGIENE BEHAVIOR OF MOTHERS				
C54.	Have you ever seen the child drinking untreated water?	Child 1 1. Yes, always 2. Yes, occasionally 3. Never	Child 2 1. Yes, always 2. Yes, occasionally 3. Never	Child 3 1. Yes, always 2. Yes, occasionally 3. Never
C55.	Have you ever seen the child eating raw vegetables?	Child1 1. Yes, always 2. Yes, occasionally 3. Never	Child 2 1. Yes, always 2. Yes, occasionally 3. Never	Child 3 1. Yes, always 2. Yes, occasionally 3. Never
C56.	Have you ever seen the child eating fruit that is not carefully washed?	Child 1 1. Yes, always 2. Yes, occasionally 3. Never	Child 2 1. Yes, always 2. Yes, occasionally 3. Never	Child 3 1. Yes, always 2. Yes, occasionally 3. Never
C57.	How often do you wash your hands?	1. Always 2. Occasionally 3. Rarely		
C58.	If always, at what points of time do you wash hands? (Do not read, Multiple-choice question) If the interviewee does wash his/her hands, tick the left square box and keep on asking him/her about other	Points of time for washing hands Before meals Before and after preparing food After urinating After defecating After playing with pet(s) After cleaning cattle sheds or poultry sheds After treating or using human feces	N 1 2 3 4 5 6 7	XP 1 2 3 4 5 6 7

No.	Question	Answer		
	times. If the interviewee says no more, ask him/her whether he/she uses soap for washing hands. If he/she does, tick the rights square box.	After cleaning the house or emptying the garbage container	8	8
		After tending to someone who is sick	9	9
		After Working in the field	10	9
		After cleaning the chamber pot, wiping the children's bottom or changing diapers	11	11
		When hands are dirty/smell unpleasant	12	12
		Other (specify:.....)	13	13
C59.	What are your concerns when buying food? ***(Multiple-choice question)***	1. Whether the food is fresh 2. Whether the food is originally specified 3. Other (specify: ……..……..) 4. Do not know		
C60.	What do you do to ensure the hygiene of food preparation for your family? ***(Multiple-choice question)***	1. Use safe water to cook food 2. Wash hands before preparing food and before serving or eating 3. Thoroughly soak food with water, and carefully wash vegetables/fruits which are eaten raw 4. Always keep cooking utensils and cooking surface clean and dry 5. Keep uncooked and cooked food separately; Use cooking utensils for uncooked and cooked food separately 6. Other (specify:……..…..)		
C61.	What do you do to ensure the hygiene of using and storing food for your family? ***(Multiple-choice question)***	1. Food should be well cooked and eaten right after cooking 2. Cover and store cooked food carefully 3. Not consume stale food 4. Cook food well before reusing it 5. Other (specify:……..…..)		
C62.	What do you do to ensure the hygiene for children as in the following circumstances: - Feeding or breastfeeding the child - Helping children to drink - Children urinating or defecating - Children's corner - Dealing with children's toys ***For the first time, investigators do not read options but let the interviewee himself/herself answer this question. Mark the interviewee's options in the left square boxes. After the interviewee finishes answering, investigators read unmarked***	**Practices of ensuring hygiene for children**	**K.Dọc**	**Dọc**
		Cook food for children well and hygienically	1	1
		Wash children's hands before feeding them	2	2
		Wash your hands before feeding the child	3	3
		Clean crockery and cutlery used for children (dish, plate, spoon, bowl, etc.)	4	4
		Feed children with other food such as porridge, rice and soup right after it is cooked	5	5
		Keep the breast clean before breastfeeding	6	6
		Do not let children suck milk from a bottle	7	7
		Boil the drinking water for children	8	8
		Wash children's hands after their urination and defecation	9	9
		Wash your hands after dealing with children's urination and defecation	10	10
		Constantly collect garbage and empty the garbage container in order that it does not attract animals and insects; and not let children play around the garbage	11	11

No.	Question	Answer				
	options in order to ask whether or not the mother practices those behaviors? If she does, mark the right square boxes to the end.	Always keep children's toys clean			12	12
		Always keep the house and the surroundings (yard, garden, floor, etc.) clean			13	13
		Other (specify:.....)			14	14
C63.	For the past 6 months, has/have your child/children been de-wormed? ***(only ask families having children from 2-5 years old)***		**Yes**	**No**		
		First child	1	2		
		Second child	1	2		
		Third child	1	2		
C64.	Do you send your children to a kindergarten/pre-school?		**Yes**	**No**		
		First child	1	2		
		Second child	1	2		
		Third child	1	2		
Information access						
C65.	For the past 12 months, have you heard of any information on clean water, environmental sanitation or the malnutrition status in children under 5 years of age?	1. Yes 2. No → ***End of interview*** 3. Do not remember → ***End of interview***				
C66.	What issues is that information about? ***(Multiple-choice question)***	1. Constructing and operating hygienic latrines 2. Guidance about operating and maintaining hygienic water sources 3. Guidance about personal hygiene behavior, and hygienic habits of eating and drinking 4. Guidance about child care 5. Environmental factors related to child malnutrition 6. Causes of child malnutrition 7. Other (specify: ……) 8. Do not remember/ Do not know				
C67.	How did you get that information? ***(Multiple-choice question)***	**Information source**		**Main source**	**Most preferable source**	
		Television, radio	1	1	1	
		Newspapers, magazines, periodicals	2	2	2	
		Communal radio station	3	3	3	
		Panels, posters	4	4	4	
		Leaflets, foldlets	5	5	5	
		Communal/village health workers	6	6	6	
		Communal meetings	7	7	7	
		Friends, family members	8	8	8	
		Other (specify:.....)	9	9	9	
From which source do you preferto receive that information?						

CHECKLIST FOR ASSESSMENT OF LATRINE CONSTRUCTION, OPERATION AND MAINTENANCE

Checklist 1. Septic tank latrine

INDICATORS			Meet standards	Do not meet standards
Construction	1	Feces processing/treatment tank includes 3 compartments	1	2
	2	Feces storage tank is not easily collapsed	1	2
	3	The cover of the storage tank is tightly sealed with cement and so it is not easily cracked	1	2
	4	The floor surface is smooth, flat and well-drained	1	2
	5	The latrine slab has a soak pit	1	2
	6	The latrine has a ventilation pipe	1	2
Operation and maintenance	1	Water for flushing is adequate; no mosquito larvae (wrigglers) or pupae live and breed in water containers	1	2
	2	There are no bad odors in the latrine	1	2
	3	Wastewater from the treatment tank is discharged into sewerage channels or seepage pits, and does not flow freely all over the ground	1	2
	4	The latrine floor is clean and has no slippery moss, waste paper or garbage on it	1	2
	5	Toilet paper (if self-decomposed) is discarded into the soakpit or into the wastepaper container with lid	1	2
	6	There are no flies or insects in the latrine	1	2
	7	There is no feces on the latrine slab	1	2
	8	The latrine shelter is well installed and so rainproof	1	2

Checklist 2. Double-vault composting latrine

INDICATORS			Meet standards	Do not meet standards
Construction	1	Walls of the feces storage tank are tightly sealed, watertight and not leaky	1	2
	2	The sludge opening is sealed with impermeable materials	1	2
	3	The latrine floor, and urine drainage channels are smooth and do not contain standing water	1	2
	4	Latrine lids are available for two pits	1	2
	5	The latrine shelter is well covered and rainproof	1	2
	6	The ventilation pipe (as for a double-vault latrine) is at least 9cm in diameter; is installed at least 40cm higher than the roof and has a fly screen	1	2
Operation and maintenance	1	The latrine floor is clean and has no wastepaper or garbage	1	2
	2	Wastepaper is discarded into the squat hole/latrine pit or into a container with lid	1	2
	3	The latrine has no bad odors	1	2
	4	No flies or insects live and breed in the latrine	1	2
	5	Two vaults are not used simultaneously	1	2
	6	Latrine fillers are adequate and discarded into the squat hole/latrine pit after each defecation	1	2
	7	No mosquito larvae (wrigglers) or pupae live in the water containers (if any), or in urine containers	1	2
	8	Feces being composted in the incubation box is not taken out within 6 months	1	2
	9	The squat hole/latrine pit of the vault in use is tightly covered, and the incubation compartment is tightly sealed.	1	2

Checklist 3. Ventilated improved latrine

INDICATORS			Meet standards	Do not meet standards
Construction	1	The latrine is not installed in the ground which is flooded or not well drained	1	2
	2	The latrine is 10m or more away from the water source for eating, drinking and daily living	1	2
	3	The latrine floor and urine drainage channels are smooth and not stagnant with urine	1	2
	4	The latrine slab is at least 20cm higher than the adjacent ground	1	2
	5	A latrine cover is available	1	2
	6	The latrine shelter is well covered and rainproof	1	2
	7	The ventilation pipe is at least 9cm in diameter, stays 40cm higher than the roof and has a fly screen	1	2
Operation and maintenance	1	The latrine floor is clean and has no paper or garbage	1	2
	2	Wastepaper is discarded into the squat hole/latrine pit	1	2
	3	Latrine fillers are adequate and discarded into the squat hole/latrine pit after each defecation	1	2
	4	There are no bad odors in the latrine	1	2
	5	There are no flies or insects in the latrine	1	2
	6	There are no mosquito larvae (wrigglers) or pupae living in water/urine containers	1	2
	7	The squat hole/latrine pit is always tightly covered	1	2

Checklist 4. Pour flush latrine

INDICATORS			Meet standards	Do not meet standards
Construction	1	The latrine is not installed in the ground which is constantly flooded or not well drained	1	2
	2	The latrine is at least 10m away from the water source for eating, drinking and daily living	1	2
	3	The feces storage tank is not easily collapsed, and the edge of the tank is at least 20cm above the ground	1	2
	4	The pit of the feces storage tank is tightly sealed and not cracked	1	2
	5	The latrine floor is smooth and well drained	1	2
	6	The latrine slab has a soak pit	1	2
	7	The sewage effluent from the feces storage tank or pipes is not leaking over the ground	1	2
Operation and maintenance	1	Water for flushing is adequate; no wigglers live in water containers	1	2
	2	There are no bad odors	1	2
	3	The latrine floor is clean and has no slippery moss, wastepaper or garbage	1	2
	4	Toilet paper (if self-decomposed) is discarded into the latrine pit or into a wastepaper container with lid	1	2
	5	There are no flies or insects in the latrine	1	2
	6	The latrine floor is clean and free of feces	1	2
	7	The latrine shelter is well installed and so rainproof	1	2

Checklist 5. Biogas latrine

		INDICATORS	Meet standards	Do not meet standards
Construction	1	The latrine is installed on high and dry ground	1	2
	2	The latrine slab has a soak pit	1	2
	3	The joints between air ventilation pipes are tightly sealed	1	2
	4	The lids of the expansion chamber and the bio-digester are 50mm thick and cover their edges	1	2
	5	The water seal is secure	1	2
	6	It is airtight	1	2
Operation and maintenance	1	Water for flushing is adequate; water containers are available	1	2
	2	The latrine floor is clean	1	2
	3	No flies or insects live and breed in the latrine	1	2
	4	The latrine slab is lean and free of feces	1	2
	5	The sewage and effluent has no bad odors after treatment	1	2
	6	There are no wigglers and fly larvae	1	2

CHECKLIST OF WATER SOURCE ASSESSMENT

Checklist 6. Drilled well water

Information on the assessment of pollution risks	Yes	No
1. The latrine is within 10m of the well	1	2
2. The latrine floor is on higher ground than the well	1	2
3. Pollution sources (garbage, cattle feces, surface water) are within 10m of the well	1	2
4. Pools of stagnant water lie within 2m of the well due to a lack of water drainage channels	1	2
5. Fencing is not built or inadequate around the hand pump, which allows the cattle to approach	1	2
6. The cement floor has a radius of <1m	1	2
7. The cement floor is cracked around the hand pump	1	2
8. Stagnant water pools are scattered on the cement floor all around the hand pump	1	2
9. The hand pump is loose at the point of attachment to the base/cement floor which could permit water to enter the hand pump	1	2

Checklist 7. Dug well water

Information on the assessment of pollution risks	Yes	No
1. The latrine is within 10m of the well	1	2
2. Pollution sources (cattle sheds, garbage containers) are within 10m of the well	1	2
3. Pools of stagnant water lie within 2m of the well due to a lack of water drainage channels	1	2
4. The water drainage channel is faulty	1	2
5. No lining is available to prevent surface water from seeping into the well	1	2
6. The cement floor has a radius of <1m	1	2
7. The walls of the well are cracked	1	2
8. The cement floor is cracked	1	2
9. A bucket and rope is left in a place where they could be contaminated	1	2

Checklist 8. Rain water

Information on the assessment of pollution risks	Yes	No
1. There is contaminated water on the rainwater collection surfaces such as roofs, gutters or down pipes.	1	2
2. Rainwater filter tank does not work well (because no gravel or sand is used in its bottom) before water runs into the storage tank, or no filter tank is available.	1	2
3. Rainwater immediately flows into the storage tank without being filtered.	1	2
4. Cracks are evidenton the tank cover, allowing the water in	1	2
5. The tap is leaky or faulty	1	2
6. The collection roofs or gutters have standing water	1	2
7. There are contaminants on the tank cover	1	2
8. A bucket is left in a place where it could be contaminated	1	2
9. The tank lacks a cover	1	2

Checklist 9. Tube well water

Information on the assessment of pollution risks	Yes	No
1. Tube well water is used for bathing, showering, washing clothes, industrial production or human exploitation of natural resources	1	2
2. Wastewater from sewer drainage channels or ditches is directly discharged into the water source	1	2
3. Tube well water is used for aquacultural activities	1	2
4. Cattle, poultry or other domestic animals come to bathe and drink	1	2
5. Garbage, human feces, cattle feces or carcass/animal corpse is evident	1	2
6. The water ducts/pipes from water source to household are contaminated	1	2
7. Water containers are contaminated	1	2
8. Water dipper placed in contaminated settings	1	2
9. The tank lacks a cover	1	2

DATA TABLES

Table 3.28. Simple logistic regression model of the relation between under-5 child malnutrition and related factors at community level

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Location of the commune										
Mountainous rural	362	1055	1.20	1.05-1.38	0.01	615	802	1.35	1.2-1.53	0.00
Delta rural	352	1587	-			574	1365	-		
Economic status of the commune										
Poor	225	535	0.87	0.59-1.3	0.51	356	404	1.47	1.03-2.08	0.03
Non-poor	489	2107	-			833	1763	-		
Classification of commune groups according to communal beneficiary index										
1 = Rich group	217	499	-			359	357	-		
2 = Rather good group	131	514	1.12	0.71-1.78	0.62	201	444	1.39	0.97-2	0.07
3 = Average group	141	571	1.20	0.77-1.88	0.42	267	445	1.86	1.31-2.65	0.00
4 = Poor group	119	521	1.36	0.87-2.14	0.18	205	435	1.43	1-2.06	0.05
5 = Very poor group	106	537	2.07	1.35-3.18	0.00	157	486	3.40	2.4-4.82	0.00
Classification of commune groups according to the rate of communal households with unhygienic latrines										
Group with low rate	214	924	-			351	787	-		
Group with medium rate	200	878	1.13	0.79-1.61	0.52	326	752	1.10	0.81-1.51	0.54
Group with high rate	300	840	1.63	1.16-2.3	0.01	512	628	2.05	1.51-2.77	0.00
Classification of commune groups according to the rate of communal households with latrines not considered unsanitary										
Group with low rate	196	920	-			308	808	-		
Group with medium rate	214	887	1.08	0.76-1.54	0.66	364	737	1.29	0.95-1.74	0.10
Group with high rate	304	835	1.72	1.23-2.41	0.00	517	622	2.28	1.7-3.06	0.00
Classification of commune groups according to the rate of communal households with water sources considered unsanitary										
Group with low rate										
Group with medium rate										
Group with high rate										
Classification of commune groups according to the rate of communal households using human feces composted for less than 6 months										

Group with low rate	206	691	-			358	539	-		
Group with medium rate	261	1004	0.94	0.64-1.37	0.73	447	818	0.85	0.6-1.19	0.35
Group with high rate	247	947	0.95	0.65-1.39	0.78	384	810	0.76	0.54-1.08	0.13
Classification of commune groups according to the rate of communal households with water sources considered unsanitary										
Group with low rate	691	1951				539	1.628			
Group with medium rate	206	508	0.94	0.67-1.32	0.73	358	831	0.81	0.59-1.1	0.17

Table 3.29. Simple logistic regression model of the relation between the under-5 child nutrition and related factors at the household level

Variable	No. of malnourished children					No. of malnourished children				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Classification of household economic status by locality										
Poor	225	535	1.63	1.33-2.01	0.00	356	404	1.51	1.25-1.82	0,00
Non-poor	489	2107	-			833	1763	-		
Household beneficiary index										
Richest	85	546	-			144	487	-		
Rich	104	540	1.21	0.89-1.65	0.22	197	447	1.46	1.14-1.88	0,00
Average	156	503	1.83	1.36-2.48	0.00	238	421	1.71	1.32-2.2	0,00
Poor	159	546	1.75	1.29-2.38	0.00	282	423	2.01	1.55-2.6	0,00
Poorest	210	507	2.37	1.74-3.24	0.00	328	389	2.35	1.8-3.07	0,00
Type of housing										
Structurally unsound	282	879	1.34	1.09-1.65	0.01	461	700	1.24	1.04-1.49	0,02
Structurally sound	432	1763	-			728	1467	-		
Housing area per capita										
< 10 m^2	450	1335	1.55	1.29-1.85	0.00	738	1047	1.62	1.39-1.89	0,00
> = 10 m^2	264	1307	-			451	1120	-		
No. of generations living together in a house										
2	462	1703	1.06	0.89-1.27	0.5	787	1378	0.98	0.84-1.15	0,84
More than 2	252	939	-			402	789	-		
The household's main source of water supply										
Unhygienic	119	387	1.01	0.76-1.36	0.93	188	318	1.09	0.85-1.41	0,49
Hygienic	595	2255	-			1001	1849	-		

Variable	No. of malnourished children					No. of malnourished children				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Assessment of the household's main water supply source										
Unhygienic	346	979	1.46	1.22-1.75	< 0.001	543	782	1.34	1.14-1.57	0,00
Hygienic	368	1663	-			646	1385	-		
Assessment of pollution risks of water supply source										
Low risk	368	1663	1.46	1.22-1.75	0.00	646	1385	1.34	1.14-1.57	0,00
Medium, high, very high	346	979	-			543	782	-		
Water treatment before using										
No	477	1687	1.05	0.87-1.27	0.59	383	809	1.48	1.24-1.78	0,00
Yes	237	955	-			806	1358	-		
Types of latrines in the survey										
Unsanitary	479	1510	1.40	1.15-1.7	0.000	796	1193	1.27	1-1.6	0,05
Sanitary	235	1132	-			393	974	-		
Checklist-based assessment of latrine construction, operation and maintenance										
Unsanitary	625	2212	1.60	1.29-1.99	0.000	247	744	1.62	1.35-1.94	0,00
Sanitary	89	430	-			942	1423	-		
Checklist-based assessment of latrine construction										
Not meeting standards	130	616	1.54	1.25-1.88	0.000	307	829	1.50	1.28-1.77	0,00
Meeting standards	584	2026	-			882	1338	-		
Checklist-based assessment of latrine operation and maintenance										
Not meeting standards	144	818	1.54	1.25-1.89	0.000	280	808	1.59	1.33-1.9	0,00
Meeting standards	570	1824	-			909	1359	-		
Using untreated or improperly treated human feces										
Less than 6 months	590	2245	0.82	0.65-1.04	0.11	997	1838	1.33	1.14-1.56	0,00
Untreated	124	397								
No. of households with bathrooms										
No	383	1122	1.34	1.11-1.62	0.00	641	864	1.5	1.28-1.77	0,00
Yes	331	1520	-			548	1303	-		
Households with hand-washing facilities										
No	147	409	1.415	1.148	0.001	242	314	2.12	1.67-2.69	0,00
Yes	567	2233	-			947	1853			
Households with bar soap/gel										

Variable	No. of malnourished children					No. of malnourished children				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
No	411	1238	1.538	1.302	< 0.001	672	977	1.538	1.302	< 0,001
Yes	303	1404	-			517	1190	-		

Table 3.30. Simple logistic regression model of the relation between under-5 child nutrition and mothers' characteristics and hygiene behavior

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Ethnic group										
Others	318	830	1.94	1.5-2.52	0.00	524	624	2.12	1.67-2.69	0.00
Kinh	396	1812	-			665	1543	-		
Mother's educational level										
1 = Secondary technical school, University	278	690	-			434	534	-		
2 = High school III	162	705	1.47	0.85-2.54	0.17	289	578	1.54	0.98-2.41	0.06
3 = Secondary school II	195	843	1.58	0.97-2.59	0.07	331	707	1.73	1.16-2.59	0.01
4 = Primary school I	59	265	1.55	0.94-2.58	0.09	101	223	1.85	1.23-2.8	0.00
5 = Illiterate, or only knowing how to read and write	20	139	2.55	1.53-4.22	0.00	0.00	125	2.56	1.69-3.89	0.00
No. of children										
1 = having one child	172	780	-			286	666	-		
2 = having two children	302	1167	1.06	0.86-1.31	0.57	505	964	1.13	0.94-1.34	0.19
3 = having three children	118	439	1.09	0.84-1.42	0.50	221	336	1.35	1.08-1.68	0.01
4 = having more than 3 children	122	256	1.63	1.21-2.19	0.00	177	201	1.55	1.19-2.03	0.00
Washing hands before eating										
No	284	966	1.16	0.97-1.38	0.10	473	777	1.14	0.98-1.32	0.09
Yes	430	1676	-			716	1390	-		

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Washing hands with water before and after preparing food										
No	446	1381	1.38	1.16-1.65	0.00	690	1137	1.10	0.95-1.28	0.19
Yes	268	1261	-			499	1030	-		
Washing hands after urinating										
No	475	1673	1.07	0.89-1.28	0.48	806	1342	1.19	1.02-1.39	0.03
Yes	239	969	-			383	825	-		
Washing hands after defecating										
No	273	1025	0.93	0.78-1.11	0.43	480	818	1.03	0.88-1.19	0.74
Yes	441	1617	-			709	1349	-		
Washing hands with water after playing with pet(s)										
No	672	2443	1.26	0.88-1.78	0.20	1113	2002	1.13	0.85-1.51	0.40
Yes	42	199	-			76	165	-		
Washing hands with water after cleaning cattle or poultry sheds										
No	568	1996	1.23	1-1.52	0.05	938	1626	1.21	1.01-1.45	0.03
Yes	146	646	-			251	541	-		
Washing hands with water after treating or using human feces										
No	618	2179	1.27	1-1.61	0.05	1011	1786	1.12	0.92-1.37	0.26
Yes	96	463	-			178	381	-		
Washing hands with water after cleaning the house or removing garbage										
No	531	1801	1.28	1.05-1.54	0.01	881	1451	1.27	1.08-1.49	0.00
Yes	183	841				308	716	-		
Washing hands with water after tending to someone who is sick										
No	669	2417	1.33	0.95-1.85	0.10	1108	1978	1.11	0.85-1.46	0.45
Yes	45	225	-			81	189	-		
Washing hands with water after working in the field										
No	430	1557	1.07	0.9-1.27	0.45	709	1278	1.03	0.89-1.2	0.67
Yes	284	1085	-			480	889	-		
Washing hands with water after cleaning the chamber pot or cleaning up the child who has defecated or after changing diapers										
No	583	2047	1.18	0.95-1.46	0.14	969	1661	1.17	0.98-1.41	0.08
Yes	131	595	-			220	506	-		
Washing hands with water when hands are contaminated/smell unpleasant										

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
No	328	1106	1.10	0.93-1.31	0.26	553	881	1.15	0.99-1.33	0.07
Yes	386	1536	-			636	1286	-		
Washing hands with water at different times										
No	690	2520	1.40	0.9-2.18	0.14	1148	2062	1.33	0.93-1.92	0.12
Yes	24	122	-			41	105	-		
No. of hand-washing acts at right times										
Less than 3	211	599	1.31	1.08-1.58	0.01	337	473	1.27	1.08-1.51	0.01
>= 3	503	2043	-			852	1694	-		
Washing hands with soap before eating										
No	593	2010	1.37	1.11-1.71	0.00	972	1631	1.31	1.09-1.57	0.00
Yes										
Washing hands with soap before and after preparing food										
No	616	2068	1.52	1.2-1.92	0.00	985	1699	1.09	0.91-1.32	0.36
Yes	98	574	-			204	468	-		
Washing hands with soap after urinating										
No	626	2258	1.13	0.88-1.46	0.33	1042	1842	1.21	0.97-1.5	0.09
Yes	88	384	-			147	325	-		
Washing hands with soap after defecating										
No	448	1549	1.07	0.89-1.27	0.49	760	1237	1.13	0.97-1.32	0.13
Yes	266	1093	-			429	930	-		
Washing hands with soap after defecating										
No	694	2518	1.49	0.93-2.39	0.10	1144	2068	0.97	0.68-1.4	0.88
Yes	20	124	-			45	99	-		
Washing hands with soap after cleaning cattle sheds or poultry sheds										
No	634	2252	1.27	0.97-1.66	0.08	1048	1838	1.23	0.98-1.53	0.07
Yes										
Washing hands with soap after treating or handling human feces										
No	645	2266	1.35	1.03-1.78	0.03	1055	1856	1.13	0.9-1.41	0.29
Yes	69	376	-			134	311	-		
Washing hands with soap after cleaning the house or handling garbage										
No	638	2265	1.20	0.93-1.56	0.17	1062	1841	1.25	1-1.55	0.05
Yes	76	377	-			127	326	-		

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Washing hands with soap after tending to someone who is sick										
No	696	2510	1.66	1.03-2.68	0.04	1153	2053	1.32	0.91-1.91	0.14
Yes	18	132	-			36	114	-		
Washing hands with soap after working in the field										
No	610	2222	1.00	0.8-1.27	0.97	1009	1823	0.94	0.77-1.15	0.54
Yes	104	420	-			180	344	-		
Washing hands with soap after cleaning the chamber pot or cleaning up the child who has defecated, or changing diapers										
No	618	2212	1.06	0.83-1.36	0.62	1038	1792	1.18	0.96-1.46	0.12
Yes	96	430	-			151	375	-		
Washing hands with soap when hands are contaminated/smell unpleasant										
No	546	1857	1.26	1.03-1.53	0.02	911	1492	1.28	1.08-1.51	0.00
Yes	168	785	-			278	675	-		
Washing hands with soap at different times										
No	702	2585	1.17	0.63-2.17	0.61	1165	2122	0.90	0.55-1.49	0.68
Yes	12	57	-			24	45	-		
No. of acts related to hand-washing with soap at right times										
Less than 3	509	1653	1.29	1.07-1.55	0.01	828	1334	1.20	1.02-1.4	0.03
>= 3	205	989	-			361	833	-		
Buying fresh food										
No	146	347	1.36	1.07-1.72	0.01	224	269	1.24	1-1.53	0.05
Yes	568	2295	-			965	1898	-		
Buy food with specified origin										
No	640	2278	1.23	0.95-1.6	0.12	1057	1861	1.18	0.95-1.47	0.14
Yes	74	364	-			132	306	-		
Preparing food with clean water										
No	179	600	1.07	0.87-1.3	0.52	287	492	1.06	0.89-1.25	0.54
Yes	535	2042	-			902	1675	-		
Thoroughly soaking food/ingredients, carefully washing fruits which are eaten raw										
No	490	1689	1.16	0.97-1.4	0.10	809	1370	1.19	1.02-1.39	0.03
Yes	224	953	-			380	797	-		
Thoroughly soaking food/ingredients, carefully washing fruits which are eaten raw										

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
No	477	1610	1.10	0.92-1.32	0.29	801	1286	1.17	1-1.37	0.04
Yes	237	1032	-			388	881	-		
Always keep kitchen utensils and cooking surface clean and dry										
	618	2230	1.04	0.82-1.33	0.73	1023	1825	0.98	0.8-1.2	0.85
	96	412	-			166	342	-		
Keeping uncooked and cooked food separate; not using the same cooking utensils used for uncooked and cooked food										
No	632	2265	1.17	0.91-1.51	0.23	1068	1829	1.49	1.19-1.86	0.00
Yes	82	377	-			121	338	-		
Cooking food well and eating right after that										
No	382	1264	1.20	1.01-1.42	0.04	637	1009	1.24	1.07-1.44	0.00
Yes	332	1378	-			552	1158	-		
Covering and storing cooked food safely and hygienically										
No	315	1058	1.08	0.9-1.29	0.39	519	854	1.07	0.92-1.24	0.41
Yes	399	1584	-			670	1313	-		
Not eating stale food										
No	441	1596	0.99	0.83-1.17	0.90	744	1293	1.08	0.93-1.25	0.33
Yes	273	1046	-			445	874	-		
Cooking the cooked food again before eating										
No	449	1637	0.95	0.8-1.14	0.60	763	1323	1.06	0.91-1.23	0.49
Yes	265	1005	-			426	844	-		
Cooking food for children well and hygienically										
No	98	357	0.90	0.7-1.16	0.40	182	273	1.08	0.88-1.34	0.46
Yes	616	2285	-			1007	1894	-		
Washing children's hands before feeding them										
No	131	457	0.98	0.78-1.22	0.85	210	378	0.98	0.81-1.19	0.85
Yes	583	2185	-			979	1789	-		
Washing your hands before feeding the children										
No	155	505	1.04	0.85-1.29	0.68	258	402	1.07	0.9-1.29	0.44
Yes	559	2137	-			931	1765	-		
Cleaning children's crockery										
No	144	366	1.39	1.1-1.74	0.01	207	303	1.12	0.91-1.38	0.27

Variable	Underweight malnutrition					Stunting malnutrition				
	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p	No. of malnourished children	No. of well-nourished children	OR	CI 95%	p
Yes	570	2276	-			982	1864	-		
Feeding children with food (porridge, rice, soup) right after it is cooked										
No	299	871	1.34	1.12-1.61	0.00	483	687	1.33	1.14-1.56	0.00
Yes	415	1771	-			706	1480	-		
Mother cleaning her breast right before breastfeeding her child										
No	373	1126	1.27	1.07-1.51	0.01	567	932	1.02	0.88-1.18	0.81
Yes	341	1516	-			622	1235	-		
Not letting children suck from bottles										
No	497	1671	1.22	1.02-1.46	0.03	805	1363	1.09	0.93-1.27	0.28
Yes	217	971	-			384	804	-		
Boiling drinking water for children										
No	173	495	1.14	0.92-1.42	0.23	286	382	1.23	1.02-1.49	0.03
Yes	541	2147	-			903	1785	-		
Washing children's hands after they urinate or defecate										
No	230	704	1.15	0.95-1.39	0.14	365	569	1.11	0.94-1.31	0.21
Yes	482	1976	-			834	1624	-		
Washing hands after working in the field										
No	232	666	1.21	1-1.46	0.05	355	543	1.21	1-1.46	0.05
Yes	482	1976	-			834	1624	-		
Always collecting and removing garbage										
No	367	1141	1.23	1.03-1.47	0.02	587	921	1.14	0.98-1.33	0.08
Yes	347	1501	-			602	1246	-		
Always keeping children's toys clean										
No	549	1805	1.37	1.13-1.67	0.00	893	1461	1.27	1.08-1.5	0.01
Yes	165	837	-			296	706	-		
Cleaning the house and the surroundings										
No	259	772	1.16	0.96-1.39	0.12	424	607	1.16	0.99-1.36	0.07
Yes	455	1870	-			765	1560	-		