

EPIDEMIOLOGY AND RISK FACTORS FOR NONFATAL DROWNING IN THE MIGRANT CHILDREN

Yinchao Zhu¹, Guozhang Xu¹, Hui Li¹, Yaqin Huang², Ke Ding³ and Jieping Chen¹

¹Institute of Non-Communicable Disease Control and Prevention, Ningbo Municipal Center for Disease Control and Prevention, Ningbo City; ²Department of Health Surveillance, Jiangbei Center for Disease Control and Prevention, Ningbo City; ³Institute of Non-Communicable Disease Control and Prevention, Yinzhou District Center for Disease Control and Prevention, Ningbo City, Zhejiang Province, PR China

Abstract. The purpose of this study was to determine the incidence and potential risk factors for nonfatal drowning among migrant workers' children in China. We conducted a cross-sectional survey of students from third to ninth grade at five Migrant Workers' Children schools in Ningbo, China in 2014. General information and a history of nonfatal drowning was obtained from self-reported questionnaires by migrant students. A multivariate logistic regression model was used to identify potential risk factors. A total 3,859 students were included in the current study. Of these, 13.4% had experienced a nonfatal drowning accident (15.2% for males, 11.2% for females). Most nonfatal drowning occurred in natural water settings. Diving into unknown water without adult supervision had the greatest association with history of nonfatal drowning [odds ratio (OR)=1.97; 95% confidential interval (CI): 1.31-2.95], followed by fishing in water (OR=1.50; 95%CI: 1.05-2.14), swimming or playing in water (OR=1.47; 95%CI: 1.02-2.12), and trying to rescue peers in the water if they were drowning (OR=1.31; 95%CI: 1.04-1.64). There were factors associated with a lower risk of drowning: having a parent accompany the child to school (OR=0.69; 95%CI: 0.51-0.93), understanding the the danger of swimming alone (OR=0.69; 95%CI: 0.48-0.99) and having a knowledge about water safety (OR=0.98; 95%CI: 0.98-0.99). The study population was at increased risk for nonfatal drowning. Preventive measures, such as improved water-safety knowledge, decreasing risky water-related activities and better supervision of children need to be developed and tested to decrease the risk of nonfatal drowning among the study population.

Keywords: drowning, injury, epidemiology, risk factors, migrant population, China

INTRODUCTION

There are large income gaps in different areas of China resulting in population

Correspondence: GZ Xu, Ningbo Municipal Center for Disease Control and Prevention, No. 237, Yongfeng Road, Haishu District, Ningbo City, Zhejiang Province, 315010, PR China. Tel: 86 574 87274542; Fax: 86 574 87361764 E-mail: xugz@nbcdc.org.cn

migrations seeking improvement. This has resulted in an increase in the number of migrant children in eastern China (National Population and Family Planning Commission, 2012). Health challenges can occur with such migrations. Infectious diseases (Anderson *et al*, 2003; Li *et al*, 2010) and injuries are common public health problems in this migrating population (Somaruga *et al*, 2011; Fitzgerald

et al, 2013). Most studies have focused on adult occupational injuries (Arici and Porru, 2011; Xia *et al*, 2012); only a few have evaluated injury risk among children (McCurdy *et al*, 2002; Zhu *et al*, 2009; Wang *et al*, 2010). One study reported migrant children are at higher risk of injury-related mortality than non-migrant local children (Wang *et al*, 2010).

Drowning is a leading cause of unintentional injury-related death (CDC, 2012; Theurer and Bhavsar, 2013; WHO, 2014). Children are at high risk of drowning even though drowning happens in all age groups (CDC, 2012; WHO, 2014). China has the most drowning deaths globally (WHO, 2014) and the drowning mortality rate is also high (4.36/100,000) (Wang, 2011). Children aged <15 years have the highest drowning mortality rate in China (6-8/100,000) (Wang, 2011).

Drowning results in mortality and morbidity. Drowning can be classified into drowning (resulting in death) and near-drowning (nonfatal drowning, NFD), and the deaths caused by drowning represent only a small fraction of all drowning cases. Drabova *et al* (2010) found the number of NFD cases was about 6 times the number of drowning cases among children. Moon and Long (2002) also found for every child drowning, 4 were hospitalized and 16 received emergency care as a NFD case. Furthermore, there are a larger number of NFD case which do not seek formal medical care and are not included in the above studies according to the injury pyramid model (WHO, 2015).

Victims of NFD may suffer severe permanent neurological sequelae resulting in a financial burden (Cohen *et al*, 2008; Drabova *et al*, 2010). Most studies have been of clinical drowning cases or of NFD cases rather than

population based (Torres *et al*, 2009; Ma *et al*, 2010). We conducted a China CDC sponsored cross-sectional survey to examine the epidemiology and risk factors for NFD among migrant workers' children in order to develop prevention strategies.

MATERIALS AND METHODS

Study site

The study area was Ningbo City in the mid-coastal region of China, south of the Yangtze River Delta. It received 1,683 mm rainfall in 2013, 70% coming during May to Oct (Ningbo Municipal Bureau of Statistics and The State Statistical Bureau Ningbo investigation team, 2013). There is abundant water in this region, including rivers, lakes, reservoirs, streams and pools (Ningbo Municipal Bureau of Water Resource, 2015). The temperature varied from 0.0°C to 35.0°C during 2013; and the monthly mean temperatures were 22.2°C, 24.9°C, 31.2°C, 30.7°C, 25.5°C, 19.9°C from May to October, respectively. High temperatures are common during the summer and autumn (Ningbo Bureau of Statistics and The State Statistical Bureau Ningbo investigation team, 2013).

Participants

We conducted this cross-sectional survey in April, 2014 using multistage sampling. Two districts (Jiangbei and Yinzhou District) were randomly selected from the six districts in Ningbo City. Five Migrant Worker Children schools were randomly selected from the 15 Migrant Worker Children schools in the study areas. Participants were all selected from grades 3 to 9 at the study schools and involved migrant children only.

Instruments

A questionnaire was developed based on a cross sectional study from Guang-

dong Province, China (Ma *et al*, 2010). The questionnaire asked about basic demographic characteristics, personality of the subject (introvert, extrovert, average), knowledge about drowning (Table 1), drowning-related beliefs (*eg*, belief in swimming alone or saving others who are drowning is dangerous), behaviors that increased the risk for drowning (*eg*, fishing in water, swimming or playing in water, diving into unknown water, boating, not using a floatation device when swimming without adult supervision), swimming skill and history of NFD.

Drowning refers to the process of respiratory impairment caused by submersion or immersion in liquid (Van Beek *et al*, 2005; WHO, 2014). The history of NFD was obtained by asking, "Have you ever experienced drowning, required self rescue or the help another for drowning in the past?" Knowledge about drowning was assessed by asking 12 questions (Table 1) and a "knowledge rate" was calculated as the number of correct answers divided by the total number of questions multiplied by 100. Self reported swimming skills were assessed by asking how far the respondent could swim at one time: excellent (≥ 100 meters), good (50-99 meters), poor (<50 meters) and non-swimmer.

Procedure

The study was conducted under the coordination of the Jiangei and Yinzhou District Education Bureau with the support of the study schools. This study was approved by the ethics committee of Ningbo Municipal CDC. Written informed consent was obtained from each participant and their parents prior to being included in this study. Trained staff from the sampled schools collected the data. Participants were requested to complete a self-administered questionnaire independently in the classroom.

Data analysis

The data were entered into Epidata 3.0 software ("The EpiData Association", Odense, Denmark) independently by two people. The Pearson's χ^2 test was used for categorical outcomes and the Kruskal-Wallis test was used for continuous outcomes to determine differences between NFD victims and non-victims. Multivariate logistic regression analysis was used to identify potential risk factors for NFD. Statistical analysis was conducted using SAS 9.2 software (SAS Institute, Cary, NC). All tests were two-sided and $p < 0.05$ was considered to be statistically significant.

RESULTS

Sample characteristics

Approximately 3,859 students were asked to participate in this study and 3,780 completed the questionnaire; the completion rate was 97.9%. Of the 3,780 participants, 2,082 (55.1%) were boys. The average age was 12.0 ± 2.0 years (range: 6-18 years) and the average length of time they had studied in Ningbo was 4.3 ± 2.0 years. Eighteen point four percent of the students came from a one-child family. Eight point nine percent went to school on a school bus. Twenty-four point six percent of participants went to school alone, 21.9% were accompanied by a parent, 13.6% by a sibling, 37.3% by a friend or classmate and 2.7% went with others. During the previous year, 32.5% of participants had at least one behavior associated with an increased risk for drowning. Seventy point nine percent of participants stated they were not swimmers.

Characteristics of nonfatal drowning

Thirteen point four percent of students reported having experienced a NFD incident during the previous year,

and the incidence rate of NFD was 15.2% for males with 11.2% for females. For the most recent NFD, if there was more than one, falling (50.3%) was the most commonly given reason, followed by having a swimming accident (eg, muscle cramp; 19.5%), diving (eg, diving from a height, diving under the water; 8.2%), boating (4.5%) and having a pre-existing health condition (eg, asthma, epilepsy; 2.9%). Sixty-seven point two percent of NFD episodes happened in natural water (eg, river, creek, stream, pond, ditch, reservoir or lake). Eighteen point six percent occurred in swimming pools, 3.8% in wells, and 2.0% in bathtubs and water containers at home. Seventy-six point five percent of NFD cases occurred during the summer, 8.6% during the spring, 8.1% during the autumn and 6.8% during the winter. NFD occurred throughout the day, especially at noon (38.6%) and in the afternoon (41.9%). Fifty-eight point six percent of victims were saved by a witness and 41.4% saved themselves. Sixteen point one percent of victims received pre-hospital resuscitation, 19.3% were sent to the hospital for treatment and 64.6% did not receive any medical treatment.

Analysis of risk factors for nonfatal drowning

The average knowledge rate was 61.2% (Table 1); victims had a lower average knowledge rate (57.1%) than non-victims (61.8%) ($p < 0.01$). Victims were significantly younger and had studied for a shorter period of time in Ningbo than non-victims. Significantly fewer (18.5% versus 22.6%) victims than non-victims were accompanied by their parents on their way to school. Compared with non-victims, victims were more likely to be male, have problems getting along with classmates or family members, have difficulties focusing on studies in class, have the intention of

saving others if they were drowning, and have a poor knowledge about the dangers of swimming alone and of rescuing others in the water. Participants, who ever fished, boated, swam or played in the water, or dove into unknown water without adult supervision during the previous year, were more likely to experience a NFD. Victims were more likely to use floatation devices when swimming than non-victims ($p < 0.01$). More NFD victims reported their swimming skill level as excellent than non-victims ($p < 0.01$) (Table 2, 3).

All risk factors with a $p < 0.05$ were entered into a multiple logistic regression model. Risk factors positively associated with NFD were: having intention of saving others if they were drowning, fishing, swimming and playing in the water and diving into unknown water without adult supervision. Age, knowledge about water safety, parents accompanying the child to and from school, understanding the danger of swimming alone were all inversely associated with NFD. Students with an introverted personality were more likely to have a NFD than those with an average personality, while there was no significant difference between students with an extroverted and average personality. The risk for NFD among students who used floatation devices in the water when swimming was 1.8 times higher than those who never swam (OR=1.82; 95% CI: 1.43-2.33) (Table 4).

DISCUSSION

The incidence of NFD among our study participants was similar to a study from New Zealand (13.4% vs 13.6%) (Gulliver and Begg, 2005). Hospital-based studies found the ratio of nonfatal to fatal drowning ranged from 6 to 20 (Moon and Long, 2002; Drabova *et al*, 2010). Wang (2011) found the drowning mortality

Table 1
Differences in knowledge level about water safety between nonfatal drowning victims and non-victims.

Survey questions	Victims, <i>n</i> (%) (<i>n</i> =507)	Non-victims, <i>n</i> (%) (<i>n</i> =3,273)	Chi-square	<i>p</i> -value
Is drowning the leading cause of mortality for children?				
Yes	231 (45.6)	1,775 (54.2)	13.25	<0.01
No	276 (54.4)	1,498 (45.8)		
Can some disease, such as heart disease, increase the risk for drowning?				
Yes	242 (47.7)	1,781 (54.4)	7.88	<0.01
No	265 (52.3)	1,492 (45.6)		
Waiting to escape by opening the door until the car's internal and external water pressure became approximately equal when a car crashes into a river, is the correct way to escape?				
Yes	240 (47.3)	1,752 (53.5)	6.75	<0.01
No	267 (52.7)	1,521 (46.5)		
Will victims suffer irreversible neurological impairment after 4~6 minutes of submersion?				
Yes	67 (13.2)	532 (16.3)	3.04	0.08
No	440 (86.8)	2,741 (83.7)		
Is recreation the major function of a gas-filled swimming ring?				
Yes	17 (3.4)	81 (2.5)	1.34	0.25
No	490 (96.6)	3,192 (97.5)		
Is 30:2 the correct ratio for cardiac massage to artificial breathing with field resuscitation?				
Yes	27 (5.3)	155 (4.7)	0.33	0.56
No	480 (94.7)	3,118 (95.3)		
Is swimming immediately after lunch dangerous?				
Yes	470 (92.7)	3,085 (94.3)	1.89	0.17
No	37 (7.3)	188 (5.7)		
Is swimming immediately after vigorous exercise dangerous?				
Yes	394 (77.7)	2,817 (86.1)	23.97	<0.01
No	113 (22.3)	456 (13.9)		
Is warm-up necessary before swimming?				
Yes	407 (80.3)	2,767 (84.5)	5.93	<0.05
No	100 (19.7)	506 (15.5)		
Is entering the water to rescue a peer who is drowning dangerous?				
Yes	407 (80.3)	2,845 (86.9)	16.14	<0.01
No	100 (19.7)	428 (13.1)		
Is shouting or calling for help the correct way to get help when a peer is drowning?				
Yes	435 (85.8)	2,933 (89.6)	6.57	<0.05
No	72 (14.2)	340 (10.4)		
Is throwing a flotation device or giving an extension the correct way to save a drowning peer?				
Yes	387 (76.3)	2,725 (83.3)	14.47	<0.01
No	120 (23.7)	548 (16.7)		

Table 2
Demographic characteristics of nonfatal drowning victims and non-victims.

	Victims, <i>n</i> (%) (<i>n</i> =507)	Non victims, <i>n</i> (%) (<i>n</i> =3,273)	Chi-square	<i>p</i> -value
Average age (years)	11.8 ± 2.0	12.0 ± 2.0	7.64	<0.01
Average school time in Ningbo (years)	4.2 ± 2.0	4.4 ± 2.0	3.86	<0.05
Gender				
Male	317 (62.5)	1,765 (53.9)		
Female	190 (37.5)	1,508 (46.1)	13.12	<0.01
One-child				
Yes	82 (16.2)	612 (18.7)		
No	425 (83.8)	2,658 (81.3)	1.89	0.17
Travel to school by school bus				
Yes	55 (11.0)	280 (8.6)		
No	447 (89.0)	2,979 (91.4)	3.00	0.08
Parents accompany child to school				
Yes	94 (18.5)	738 (22.6)		
No	413 (81.5)	2,533 (77.4)	4.13	<0.05

The inconsistencies among the total frequencies of certain variables were caused by missing data.

among children in China aged <15 years to be 6-8 per 100,000. The incidence of NFD was 13.4% among the migrant children in this study. We estimate the ratio of nonfatal to fatal drowning incidents in our study to be greater than 100, which is much higher than reported previously (Moon and Long, 2002; Drabova *et al*, 2010). The large difference in the ratio of nonfatal to fatal drowning incidents could be the different study design. The drowning definition employed in this study (WHO, 2014), did not use medical experience as a criterion. This broader definition might have resulted in the higher prevalence of NFD (incidents found) in our study. This has the advantage of making it easier to identify NFD cases (64.6% in our study), can result in a greater incidence and may make our study uncomparable to other studies. Over-estimation of NFD incidence is inevitable with self-reported studies, such as ours (Ma *et al*, 2010).

It is difficult to determine the drowning-related mortality among migrant workers' children because of the unknown base population as the denominator. Therefore, it is not possible to make a direct comparison of drowning related mortality between the migrant children and others. Several studies have reported children in rural China have a higher drowning-related mortality rate than their urban counterparts (Hu *et al*, 2010; Liu *et al*, 2012). In our study, the NFD incidence rate among migrant children in Ningbo was more than twice that of native rural children (5.65%) in Guangdong Province (Guo *et al*, 2010). We theorize migrant children may have the highest drowning related mortality and are at a higher risk for drowning than native rural or urban children. Consequently, they should be considered as a target group for drowning prevention in China.

Being a migrant child has been re-

Table 3
Selected characteristics of nonfatal drowning victims and non-victims.

	Total, <i>n</i> (%)	Victims, <i>n</i> (%) (<i>n</i> =507)	Non-victims, <i>n</i> (%) (<i>n</i> =3,273)	Chi-square	<i>p</i> -value
Believe swimming alone is dangerous					
No	363 (9.6)	84 (16.6)	279 (8.5)	33.07	<0.01
Yes	3,413 (90.4)	421 (83.4)	2,992 (91.5)		
Believe saving others who are drowning is dangerous					
No	151 (4.0)	32 (6.3)	119 (3.6)	8.17	<0.01
Yes	3,626 (96.0)	475 (93.7)	3,151 (96.4)		
Intention to save peers in the water if they are drowning					
No	2,255 (59.8)	257 (50.8)	1,998 (61.2)	19.72	<0.01
Yes	1,516 (40.2)	249 (49.2)	1,267 (38.8)		
Fished in the water without adult supervision during the previous year					
No	3,366 (89.6)	388 (77.3)	2,978 (91.5)	94.04	<0.01
Yes	391 (10.4)	114 (22.7)	277 (8.5)		
Went boating without adult supervision during the previous year					
No	3,442 (91.5)	410 (81.5)	3,032 (93.1)	75.48	<0.01
Yes	318 (8.5)	93 (18.5)	225 (6.9)		
Swam or played in the water without adult supervision during the previous year					
No	3,398 (90.3)	397 (78.9)	3,001 (92.0)	85.20	<0.01
Yes	366 (9.7)	106 (21.1)	260 (8.0)		
Used a flotation device when swimming during the previous year					
Never swimming	2,232 (59.4)	216 (42.9)	2,016 (61.9)	66.68	<0.01
Yes	1,252 (33.3)	241 (47.8)	1,011 (31.1)		
No	276 (7.3)	47 (9.3)	229 (7.0)		
Dived into unknown water without adult supervision during the previous year					
No	3,513 (93.4)	417 (82.7)	3,096 (95.1)	108.42	<0.01
Yes	247 (6.6)	87 (17.3)	160 (4.9)		
Focused on study in class					
Easy	2,408 (64.0)	297 (58.9)	2,111 (64.8)	6.56	<0.05
Difficult	1,353 (36.0)	207 (41.1)	1,146 (35.2)		
Personality					
Introvert	499 (15.5)	80 (19.2)	419 (15.0)	17.65	<0.01
Average	801 (25.0)	71 (17.0)	730 (26.2)		
Extrovert	1,909 (59.5)	266 (63.8)	1,643 (58.8)		
Gets along with classmates					
Good	3,565 (94.7)	460 (91.5)	3,105 (95.2)	12.58	<0.01
Bad	198 (5.3)	43 (8.5)	155 (4.8)		
Gets along with family members					
Good	3,564 (94.7)	451 (89.7)	3,113 (95.5)	29.99	<0.01
Bad	198 (5.3)	52 (10.3)	146 (4.5)		
Self reported swimming skill					
Excellent	168 (4.5)	43 (8.5)	125 (3.8)	24.44	<0.01
Average	489 (12.9)	68 (13.5)	421 (12.9)		
Poor	439 (11.7)	63 (12.5)	376 (11.6)		
Non-swimmer	2,668 (70.9)	330 (65.5)	2,338 (71.7)		

The inconsistencies among the total frequencies of certain variables were caused by missing data.

Table 4
Multivariate analysis of risk factors for nonfatal drowning victims.

Risk factors	Odds ratio	95% CI	Chi-square	p-value
Age	0.92	0.87-0.97	7.92	<0.01
Knowledge level	0.98	0.98-0.99	16.08	<0.01
Parents accompany child to school				
Yes	0.69	0.51-0.93	5.74	<0.05
No	Reference			
Believe swimming alone is dangerous				
Yes	0.69	0.48-0.99	3.88	<0.05
No	Reference			
Intend to save others if they are drowning				
Yes	1.31	1.04-1.64	5.33	<0.05
No	Reference			
Fished in water without adult supervision during the previous year				
Yes	1.5	1.05-2.14	5.00	<0.05
No	Reference			
Swam or played in water without adult supervision during the previous year				
Yes	1.47	1.02-2.12	4.31	<0.05
No	Reference			
Used a floatation device in the water during the previous year				
No	1.37	0.91-2.05	0.01	0.95
Yes	1.82	1.43-2.33	11.46	<0.01
Never swimming	Reference			
Dived into unknown water without adult supervision during the previous year				
Yes	1.97	1.31-2.95	10.66	<0.01
No	Reference			
Personality				
Introvert	1.76	1.21-2.57	4.07	<0.05
Extrovert	1.65	1.22-2.24	3.34	0.07
Average	Reference			

CI, confidence interval.

ported to be a risk factor for unintentional drowning in children (Schyllander *et al*, 2013). Migrant children experience changes in living factors, such as geography, weather and culture, which can influence the risk for drowning (Sevilla-Godinez *et al*, 2010; Wang, 2011; Fralick *et al*, 2013; Schyllander *et al*, 2013). Migrations from areas where water is deficient to areas where water is abundant increase the risk for unintentional drowning (Schyllander *et al*, 2013). Newly arrived children need time to adapt to the new environment and

are more likely to take risks than local children (Nakash *et al*, 2012). Migrant children may also spend more time at home alone because of social limitations and poor family economic status (National Population and Family Planning Commission, 2012), which may also be related to their greater exposure to risk factors for drowning (Sevilla-Godinez *et al*, 2010).

Many studies found adult supervision is important to prevent drowning in children (Petross *et al*, 2009; Ma *et al*, 2010; Schnitzer *et al*, 2014). We also found pa-

rental accompaniment of children to and from school was protective against NFD. Yang *et al* (2006) found in China 61.7% of childhood drowning events occurred within 500 meters of the child's school or home. Parents are mostly to blame for childhood drowning near home and near school since children are not allowed to leave school during school hours (Weiss and American Academy of Pediatrics Committee on Injury, 2010). Parents should not permit their children to be unsupervised when they go to and from school. In our study, 75.5% of our study participants were either unaccompanied or accompanied only by other juveniles on their way to and from school. This inadequate supervision may be more common among migrant workers, who have little time and energy for this supervision because both parents may work long, strenuous hours (Arici and Porru, 2011). The larger number of children in migrant families may also prevent them from having time to supervise their children. Community-based crèches and parents/village support groups have been considered as a solution for supervision in Bangladesh (Rahman *et al*, 2010). Taking a school bus to school is another feasible solution.

A child's cognitive susceptibility may play an important role in risk-taking behavior and may have a stronger influence than environment on risk for NFD (Jackson, 1998). A perceived threat of injury and vulnerability may decrease the risk for injury (McCool *et al*, 2009; Poudel-Tandukar *et al*, 2007). Low risk perception and overestimation of swimming ability can occur among children with underdeveloped cognition and may cause them to be more impulsive and take greater risks (Gulliver and Begg, 2005; Ma *et al*, 2010), such as diving in unknown water. Our

study found more NFD victims held the belief the dangers of water activities were low and assessed their own swimming skills as excellent. A program of injury awareness education for the youth to enhance risk appraisal, has been proven to be significantly effective (Ho *et al*, 2012). Peer pressure is also associated with risk-taking behavior (Quan *et al*, 2006). Children might flaunt their abilities in the water to avoid social exclusion even if they are poor swimmers.

The relationship between swimming ability and the risk for drowning is controversial (Weiss and American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention, 2010; Wallis *et al*, 2014). Swimming skill was not associated with NFD on multivariate analysis in our study. Further studies are needed to clarify the relationship between swimming ability and risk of drowning. How to determine swimming skill level objectively and quantitatively is important before this issue can be further clarified. Some programs are recommended, such as formal swimming training and targeted education to correct parental misconceptions, such as "developing a child's swimming skills is better than adult supervision." (Weiss and American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention, 2010).

Drowning locations vary widely by country, location and age group (Weiss and American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention, 2010; Wallis *et al*, 2015). In our study, more than half of NFD incidents happened in a natural body of water, consistent with another NFD and fatal drowning report from China (Nong and Yang, 2006), and more than two-thirds have been reported to be related to water recreation (Ma *et al*, 2010). Natural bodies of water may be free

and more convenient. People may have less restraint in natural bodies of water than swimming pools (Quan *et al*, 2006). Public swimming pools are thought to be safer than open water, although drowning may still occur in them (CDC, 2012; Tyebally and Ang, 2010). However, the cost and limited availability of swimming pools makes them inaccessible to migrant children. Specifying safe natural bodies of water, having volunteer lifeguards, and offering free swimming lessons may be feasible methods to reduce the risk for drowning among migrant children in China.

Effective drowning prevention strategies depend not only on passive measures (*eg*, environment improvement, policy implementation) but on individual education. Newly arrived children from areas without natural bodies of water should be educated about the risks of water when moving to areas with natural bodies of water (Garssen *et al*, 2008). Parents of these children also need to be educated about these risks (Garssen *et al*, 2008). This education for both children and parents has been shown to be effective in reducing unintentional drowning (Moran and Stanley, 2006; Guo *et al*, 2010) and has been implemented widely in developed countries. Water safety education should be a priority in developing countries with high incidence rates of childhood drowning.

There were several limitations in our current study. First, recall bias is an inevitable limitation of cross-sectional surveys. NFD was self-reported; this could be considered a sensitive question vulnerable to social desirability bias. Some information, such as swimming skill level and type of personality, are based on self-evaluation and may not be accurate. Second, the results of this study cannot be applied to other situations given our study sample and location. Our study does provide

insight into NFD among the migrant children in China.

In conclusion, our study subjects had a high incidence of NFD. Swimming ability was not associated with NFD, but lack of knowledge about water safety and lack of parental supervision were significantly associated with NFD. Education of both these children and their parents about water safety may reduce the risk for NFD. Future studies using the application of this education on the incidence of NFD in this population are needed.

ACKNOWLEDGEMENTS

We are especially grateful to the Institute of Injury Prevention, China CDC and the program for Ningbo Leading Team of Science and Technology Innovation (2012B82018) for financial and technical support. We also thank Mr Wenjun Ma from the Guangdong Province CDC for revision of the questionnaire. We sincerely appreciate the Jiangbei and Yinzhou District Education Bureaus, and the participant schools for their cooperation.

REFERENCES

- Anderson AF, Qingsi Z, Hua X, Jianfeng B. China's floating population and the potential for HIV transmission: a social-behavioural perspective. *AIDS Care* 2003; 15: 177-85.
- Arici C, Porru S. Work-related accidents and diseases in migrant workers. *G Ital Med Lar Ergon* 2011; 33 (suppl 2): 10-5 (in Italian).
- Centers for Disease Control and Prevention (CDC). Drowning--United States, 2005-2009. *MMWR Morb Mortal Wkly Rep* 2012; 61: 344-7.
- Cohen RH, Matter KC, Sinclair SA, Smith GA, Xiang H. Unintentional pediatric submersion-injury-related hospitalizations in the United States, 2003. *Injury prevention: J Int Soc Child Adoles Injury Prev* 2008; 14: 131-5.

- Drabova M, Veleminsky M, Sr, Toracova L, Peslova E, Veleminsky M Jr. Retrospective analysis of paediatric injuries associated with water in Czech Republic in the context of the European at worldwide situation. *Int Med J Exp Clin Res* 2010; 16: SC13-7.
- Fitzgerald S, Chen X, Qu H, Sheff MG. Occupational injury among migrant workers in China: a systematic review. *Injury prevention: J Int Soc Child Adolesc Injury Prev* 2013; 19: 348-54.
- Fralick M, Denny CJ, Redelmeier DA. Drowning and the influence of hot weather. *PLOS One* 2013; 8: e71689.
- Garssen MJ, Hoogenboezem J, Bierens JJ. Reduction of the drowning risk for young children, but increased risk for children of recently immigrated non-Westerners. *Ned Tijdschr Geneesk* 2008; 152: 1216-20 (in Dutch).
- Gulliver P, Begg D. Usual water-related behaviour and 'near-drowning' incidents in young adults. *Aust NZ J Public Health* 2005; 29: 238-43.
- Guo QZ, Ma WJ, Xu HF, et al. Evaluation on the health education program regarding prevention of non-fatal drowning among school-aged children in Lianping county, Guangdong province. *Chin J Epidemiol* 2010; 31: 22-6.
- Ho KM, Litton E, Geelhoed E, et al. Effect of an injury awareness education program on risk-taking behaviors and injuries in juvenile justice offenders: a retrospective cohort study. *PLOS One* 2012; 7: e31776.
- Hu G, Baker SP, Baker TD. Urban-rural disparities in injury mortality in China, 2006. *J Rural Health* 2010; 26: 73-7.
- Jackson C. Cognitive susceptibility to smoking and initiation of smoking during childhood: a longitudinal study. *Prev Med* 1998; 27: 129-34.
- Li X, Zhang H, Jiang S, et al. Active pulmonary tuberculosis case detection and treatment among floating population in China: an effective pilot. *J Immig Minor Health* 2010; 12: 811-5.
- Liu Q, Zhang L, Li J, et al. The gap in injury mortality rates between urban and rural residents of Hubei Province, China. *BMC Public Health* 2012; 12: 180.
- Ma WJ, Nie SP, Xu HF, et al. An analysis of risk factors of non-fatal drowning among children in rural areas of Guangdong Province, China: a case-control study. *BMC Public Health* 2010; 10: 156.
- McCool J, Ameratunga S, Moran K, Robinson E. Taking a risk perception approach to improving beach swimming safety. *Int J Behav Med* 2009; 16: 360-6.
- McCurdy SA, Samuels SJ, Carroll DJ, Beaumont JJ, Morrin LA. Injury risks in children of California migrant Hispanic farm worker families. *Am J Industr Med* 2002; 42: 124-33.
- Moon RE, Long RJ. Drowning and near-drowning. *Emerg Med* 2002; 14: 377-86.
- Moran K, Stanley T. Toddler drowning prevention: teaching parents about water safety in conjunction with their child's in-water lessons. *Int J Injury Contr Saf Promot* 2006; 13: 254-6.
- Nakash O, Nagar M, Shoshani A, Zubida H, Harper RA. The effect of acculturation and discrimination on mental health symptoms and risk behaviors among adolescent migrants in Israel. *Cul Divers Ethnic Monor Psychol* 2012; 18: 228-38.
- National Population and Family Planning Commission. Report on China's migrant population development 2012. Beijing: China Population Publishing House, 2012.
- Ningbo Municipal Bureau of Statistics, The State Statistical Bureau Ningbo investigation team. Ningbo statistical yearbook. Ningbo: China Statistics Press, 2013.
- Ningbo Municipal Bureau of Water Resource. The profile of water resource in Ningbo city. Ningbo: Ningbo Municipal Bureau of Water Resource, 2015. [Cited 2015 Jul 17]. Available from: <http://www.nbwaterv.govcn>. 2015.
- Nong Qx, Yang L. Analysis on drowning among children in rural areas of Guangxi province. *Chin J Public Health* 2006; 22: 1043-4.

- Petrass L, Blitvich JD, Finch CF. Parent/Care-giver supervision and child injury: a systematic review of critical dimensions for understanding this relationship. *Fam Community Health* 2009; 32: 123-35.
- Poudel-Tandukar K, Nakahara S, Ichikawa M, Poudel KC, Jimba M. Risk perception, road behavior, and pedestrian injury among adolescent students in Kathmandu, Nepal. *Inj Prev* 2007; 13: 258-63.
- Quan L, Crispin B, Bennett E, Gomez A. Beliefs and practices to prevent drowning among Vietnamese-American adolescents and parents. *Inj Prev* 2006; 12: 427-9.
- Rahman A, Miah AH, Mashreky SR, Shafinaz S, Linnan M, Rahman F. Initial community response to a childhood drowning prevention programme in a rural setting in Bangladesh. *Inj Prev* 2010; 16: 21-5.
- Schnitzer PG, Dowd MD, Kruse RL, Morrongoello BA. Supervision and risk of unintentional injury in young children. *Inj Prev* 2014 May 21.
- Schyllander J, Janson S, Nyberg C, Eriksson UB, Stark Ekman D. Case analyses of all children's drowning deaths occurring in Sweden 1998-2007. *Scand J Public Health* 2013; 41: 174-9.
- Sevilla-Godinez RE, Gomez-Lomeli ZM, Chavez-Ponce B, Orozco-Valerio M, Celis-de la Rosa A. Prevalence of risk factors for drowning at home related to the socioeconomic level. *Rev Med Inst Mexic Seguro Soc* 2010; 48: 645-52.
- Somaruga C, Troja Martinazzoli MG, Brambilla G, Colosio C. Migrant workers in agriculture and animal husbandry: experiences of health surveillance. *G Ital Med Lav Ergon* 2011; 33 (suppl 2): 41-3 (in Italian).
- Theurer WM, Bhavsar AK. Prevention of unintentional childhood injury. *Am Fam Physician* 2013; 87: 502-9.
- Torres SF, Rodriguez M, Iolster T, et al. Near drowning in a pediatric population: epidemiology and prognosis. *Arch Argen Pediatr* 2009; 107: 234-40.
- Tyebally A, Ang SY. Kids can't float: epidemiology of paediatric drowning and near-drowning in Singapore. *Singapore Med J* 2010; 51: 429-33.
- Van Beeck EF, Branche CM, Szpilman D, Modell JH, Bierens JJ. A new definition of drowning: towards documentation and prevention of a global public health problem. *Bull World Health Organ* 2005; 83: 853-6.
- Wallis BA, Watt K, Franklin RC, Taylor M, Nixon JW, Kimble RM. Interventions associated with drowning prevention in children and adolescents: systematic literature review. *Inj Prev* 2015; 21: 195-204.
- Wang SY. Epidemiological features and research progress of injury in China. *Chin J Epidemiol* 2011; 32: 637-41.
- Wang H, Smith GA, Stallones L, Xiang H. Injury-related childhood mortality in migrant households in a southern city of China. *J Int Soc Child Adolesc Inj Prev* 2010; 16: 161-5.
- Weiss J, American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention. Prevention of drowning. *Pediatrics* 2010; 126: e253-62.
- World Health Organization (WHO). Violence and injury prevention and disability. Geneva: WHO, 2014. [Cited 2015 Jul 10]. Available from: <http://www.who.int/mediacentre/factsheets/fs347/en/>
- World Health Organization (WHO). Injuries and violence: the facts 2014. Geneva: WHO, 2015. [Cited 2015 Jul 17]. Available from: http://www.who.int/violence_injury_prevention/en/. 2015
- Xia QH, Jiang Y, Yin N, Hu J, Niu CJ. Injury among migrant workers in Changning district, Shanghai, China. *Int J Inj Contr Saf Promot* 2012; 19: 81-5.
- Yang L, Nong QX, Li CL, Feng QM. A case-control study on risk factors of drowning among children aged between 1 and 14 in rural areas of Guangxi. *Clin J Epidemiol* 2006; 27: 853-6.
- Zhu XX, Chen K, Liu QM, et al. Study on the risk factors of injuries among children at school age, from the families of migrant workers in Hangzhou city. *Chin J Epidemiol* 2009; 30: 911-4.