

# TSUNAMI MORTALITY IN ACEH PROVINCE, INDONESIA

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## ABSTRACT

Nine tsunami-affected districts in Aceh, Indonesia were surveyed between February and August 2005 with the aim of characterizing tsunami mortality. The surveys encompassed 1,653 tsunami-displaced households with a pre-tsunami population of 9,635 individuals. Of the original pre-tsunami population, a total of 1,642 people, or 17.0%, were reported as dead or missing in the tsunami. Crude mortality rates in the four survey areas ranged from a high of 23.6% in Aceh Jaya district on the West Coast to 5.3% on the East Coast. Age-specific mortality rates followed a similar pattern across the four survey areas, with the highest mortality concentrating in the youngest children (aged 0-9) and oldest adults (70+). The relative risk of mortality was significantly greater among females than males ( $p < 0.05$  for all surveys). While sex-specific mortality rates differed significantly between the ages of roughly 10 to 69, among younger children (particularly 0-4) and adults 70 or over, sex-specific mortality differences disappeared.

## INTRODUCTION

On the morning of Sunday, December 26, 2004 an earthquake registering 9.0 on the Richter scale struck off the western coast of North Sumatra, triggering massive waves that devastated coastal regions throughout the Indian Ocean rim. Indonesia's Aceh Province suffered the greatest mortality with widespread destruction extending along more than 1,000 kilometers of coastline. Approximately one year after the tsunami, Indonesian government estimates totaled 129,775 deaths, 38,786 missing and 504,518 tsunami-displaced in Aceh Province (UNIMS/BRR, 2005).

Beginning in February 2005, Johns Hopkins Bloomberg School of Public Health, with the local support and cooperation of Mercy Corps, conducted four rounds of household surveys in nine tsunami-affected districts of Aceh Province to measure mortality and other impacts of the tsunami. The surveys covered essentially the entire coastline from Nagan Raya and Aceh Barat districts on the southwestern coast to Aceh Utara on the eastern coast (see Figure 1).

## METHODS

An initial round of surveys was undertaken in February 2005 at the request of Mercy Corps both to assess the demographic impact of the tsunami and to measure near-term intentions of internally displaced persons (IDPs) regarding whether or not to return to their original homes and livelihoods. The first survey was conducted in the districts of Nagan Raya and Aceh Barat (the Meulaboh area) which had an estimated population of 26,905 IDPs (Indonesian National Army (TNI), 2005). The survey was limited to these two districts because south of Nagan Raya was considered less affected, and north of Aceh Barat was inaccessible via road at that time; four sub-districts within the survey area with an estimated 4,428 IDPs were excluded due to inaccessibility and reported insecurity. A multi-stage cluster sampling design (a total of 20 clusters with 20 households each were interviewed) was used, with probability proportional to the estimated size of IDP locations (using figures provided by provided by local district and military officials).

In March 2005, a second round of interviews was conducted in the more densely populated districts of Banda Aceh and Aceh Besar with a combined estimated IDP population of 215,379 IDPs residing in those districts. This survey, also employed a multi-stage cluster design (a total of 20 clusters with 24 households each were interviewed), maintained a focus on mortality but also added questions on illness and injury and access to humanitarian services.

In July and August 2005, the Johns Hopkins team returned to Aceh Province to complete mortality surveys in five additional districts. The East Coast survey in July focused on Pidie, Biruen, Aceh Utara, and Lhoksumawe, with an estimated population of 152,348 IDPs (the sub-district of Maura Batu in Aceh Utara was excluded because the survey team could not obtain permission from local authorities to conduct interviews). The August survey concentrated on the single district of Aceh Jaya on the West Coast, with an estimated 40,422 IDPs (the sub-district of Teunom was excluded because it was difficult to reach by road and NGOs working in the area reported that few IDPs remained there). Given that the Meulaboh and the Banda Aceh surveys employed similar cluster designs, it was decided to adopt the same basic sampling strategies and sample sizes in the East Coast and West Coast surveys in order to estimate tsunami mortality in each of the four areas with similar precision and to be able to compare mortality patterns across the four survey areas.

As noted, sampling was conducted based on lists of known locations of IDPs using probability proportional to size sampling methods to select clusters. By March, IDPs were categorized as residing in Spontaneous Settlement Camps (usually tents or make-shift shelters), in Temporary Living Centers or barracks (semi-permanent wooden structures), or with Host Communities. Displaced population information generally was reported by settlement type and interviews were conducted proportionally to sub-district estimates from local authorities for the Banda Aceh, East coast, and West Coast surveys. In the case of the February 2005 survey in Meulaboh, the sample was apportioned equally between households living in IDP camps and households living with host families, based on the best available local information at the time of the survey.

Mortality information was collected by asking respondents to list all household members on the day preceding the tsunami and then provide their age, sex, and post-tsunami status. Post-tsunami status was recorded as alive and residing in the household, alive and residing outside of the household, dead, or missing. For the mortality analysis, these four categories were reduced to a dichotomous variable of alive or presumed dead (comprising dead or missing).

The questionnaire was developed in English and translated to Bahasa. Back translation and field testing were carried out with local assistance by Mercy Corps. Most of the interviewers were Acehnese university students. All interviewers received two days of training prior to the survey and participated in field testing the questionnaire. Data analysis was performed using STATA Version 8 (Stata Corp, College Station, TX) and SPSS Version 12.0 (SPSS Inc., Chicago, IL).

Permission to conduct the surveys was obtained from local authorities in Aceh Province, including both the Ministry of Foreign Affairs and the police department. Informed verbal consent was obtained from each respondent before interviews were conducted. The study was approved by the Johns Hopkins Bloomberg School of Public Health, Committee on Human Research.

## **RESULTS**

The four surveys of tsunami-displaced populations in Aceh Province, Indonesia included a total of 1,653 households (Meulaboh n=388, Banda Aceh n=478, East Coast n=400, West Coast n=387) with a total pre-tsunami population of 9,635 individuals. Of the original pre-tsunami population, 1,642 people, or 17.0% of household members, were reported as dead or missing in the tsunami. A total of 597 households, 36.1% of the total, reported one or more persons dead or missing.

Crude mortality rates in the four survey areas varied significantly. The highest mortality rate (here expressed as a percentage of household members exposed to the tsunami who died or went missing during the tsunami) was 23.6% in Aceh Jaya district on the West Coast. In the Banda Aceh/Aceh Besar districts, crude mortality was 22.9%, while in the Meulaboh survey, covering Aceh Barat and Nagan Raya districts on the southwestern coast, overall mortality was 13.9%. The lowest mortality, 5.3%, was reported in the East Coast survey, covering Pidie, Biruen, and Aceh Utara districts.

Given the different levels of overall mortality, age-specific mortality rates followed a similar pattern across the four survey areas (see Figure 2) with the highest mortality concentrating in the youngest children (aged 0-9) and oldest adults (70+) and lower mortality found among older children (10-19) and younger adults (20-39). The relative risk of mortality was greater among females than males in all survey areas. Risk of death for females as compared to males in the four survey areas was as follows: Meulaboh: 2.1; West Coast: 1.6; Banda Aceh: 1.2; and East Coast: 1.5.

Aggregating and weighting data (based on estimates of pre-tsunami population size<sup>1</sup>) from all four surveys enabled us to estimate crude mortality among tsunami-displaced households at 14.1%. The weighted male mortality rate (all ages) was 12.0% and the weighted female mortality rate was 16.4%; the risk of death was 1.4 times higher for females than for males. Comparing aggregated age-specific mortality rates for males and females (see Figure 3), it can be seen that the sex-specific mortality rates differed between the ages of roughly 10 to 69. Among younger children, the sex-specific mortality differences grew less pronounced and, between the ages of 0-4, disappeared altogether (tsunami mortality among boys 0-4 was 25.4% and, among girls 0-4, tsunami mortality was 24.1%). Similarly, for adults aged 70 and over, there appeared to be little difference in tsunami mortality patterns for males and females.

## DISCUSSION

Crude death rates for the four survey areas ranged from a high of 23.6% in Aceh Jaya district on the western coastline close to the earthquake epicenter, to 5.3% in districts along the east coast of Aceh Province, where the effects of both the earthquake and the tsunami waves were attenuated by distance and geography. Within days of the tsunami, it was feared that mortality might have been exceptionally high in Aceh Jaya district. A rapid health assessment conducted by the International Rescue Committee (IRC) in the city of Calang in January 2005 reported that local government officials were estimating that 70% of the town's population had perished in the tsunami; the IRC study had found that, of 316 households surveyed, over 65% had reported at least one death of an immediate household member as a result of the tsunami (Brennan, 2005).

The high mortality rates found in Banda Aceh and Aceh Besar districts (22.9%) may be due to several factors. The earthquake and the flooding that ensued not only churned through densely populated urban areas but churned up millions of tons of concrete, brick, wood, glass, and metal. In addition, the Banda Aceh/Aceh Besar area is situated on alluvial flood plain and the relatively slow elevation increase resulted in flooding that extended further inland than in other survey areas where elevation change was more pronounced. In Aceh Barat and Nagan Raya districts, though overall mortality certainly was high (13.9%), sub-district mortality rates varied considerably from a low of 1.8% in Bubon, whose westernmost boundary lies more than 10 kilometers from the coastline, to a high of 33.1% in Samatiga, a sub-district with a lengthy coastline.

Although the levels of crude mortality differed by geographic area, all four studies found that age-specific death rates followed a fairly normal (albeit greatly elevated) J-curve of mortality, with highest mortality among the youngest children and the oldest adults. The data does support the view that the tsunami did its worst damage among those who were least able to withstand its force (WHO, 2005; ICMH, 2005).

Tsunami mortality among males and females also differed significantly, with nearly two-thirds of those reported dead or missing being female. Taking all ages together, females were 1.44 times as likely to die in the tsunami as males. Anecdotal impressions reported shortly after the tsunami noted a dearth of women and children among the survivors. One non-governmental organization (Oxfam, 2005) offered this explanation, drawn from interviews with survivors:

*“In rural coastal areas, many men who were fishing far out at sea survived, as the giant waves passed harmlessly under their small boats. When the waves hit the shore, they flattened coastal communities and killed many of the women and children, most of whom were at home on that Sunday morning. In agricultural areas, men were often working out in the fields or doing errands away from the house, or were taking produce to markets...The sheer strength needed to stay alive in the torrent was often also decisive in determining who survived. Many women and young children, unable to stay on their feet, or afloat, in the powerful waves, simply tired and drowned. Women clinging to one or more children would have tired even more quickly.”*

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<sup>1</sup> Weighted calculations were based on population estimates of tsunami-affected communities derived by the Asian Development Bank and applied to the nine districts surveyed.

Where physiological differences combined with gendered social or behavioral patterns, male and female mortality differed significantly, with the disadvantage always going to the females. However, at the extremes of age—particularly children 0-4 and among adults 70 or over—sex-specific mortality differences seemed disappear.

In assessing the mortality impact of the tsunami in Indonesia, there are several limitations to this survey. First, the study focuses on displaced households only and may not be generalizable to the broader tsunami-affected population. It is likely that people who lost their houses to the tsunami would be more likely to have lost household members as well. If this is so, then the survey would probably overestimate tsunami mortality rates.

Second, households where no adult member survived had no way of being included in the survey, thereby creating a survivor bias. This bias might be low on the East Coast, where overall mortality was lower but it might be quite pronounced in areas along the West Coast, particularly Aceh Jaya, where government reports indicated that the tsunami may have wiped out up to 70% of the population in some areas. Our preliminary estimates, based on village-level comparisons of household survival ratios to individual survival ratios, suggest that adjusting for a survival bias could increase overall mortality by as much as 10%. Combining this figure to our sample-derived crude mortality estimate of over 14% means that the tsunami could have killed up to 25% of the population at risk.

Finally, the surveys were conducted at different times over a seven-month period, which could have had an effect on recall error. It is also possible that households who remained displaced after the passage of more than one-half year might have had different mortality experiences than those who returned earlier to their villages.

## CONCLUSIONS

As of December 2005, in the nine districts included in the four surveys, there were an estimated 163,650 people reported as dead (129,775) or missing (38,786); according to both Indonesian government and United Nations estimates, tsunami mortality in these nine districts accounted for 97.5% of all tsunami mortality in Aceh Province (UNIMS/BRR, 2005). Although our study is limited by its focus on displaced households, and by survivor bias that was undoubtedly significant in high-impact areas, the data do present a plausible picture of tsunami mortality in Aceh Province.

The differential risks presented by this enormous natural disaster were, first and foremost, geographical. Anyone too close to the shoreline on the West Coast of Aceh on the morning of December 26, 2005 had poor odds of survival. But age, too, played an important role, as it does in more mundane life-and-death scenarios. Finally, and perhaps most significant in terms of longer-term demographic impact, was the higher risk faced by females in all but the youngest and oldest ages. The full human impact of the Asian tsunami in Aceh Province, in terms of lives lost or damaged, may never be fully measured but certainly the female deficit, whether measured in households or in communities, may be the tsunami impact that is felt most deeply.

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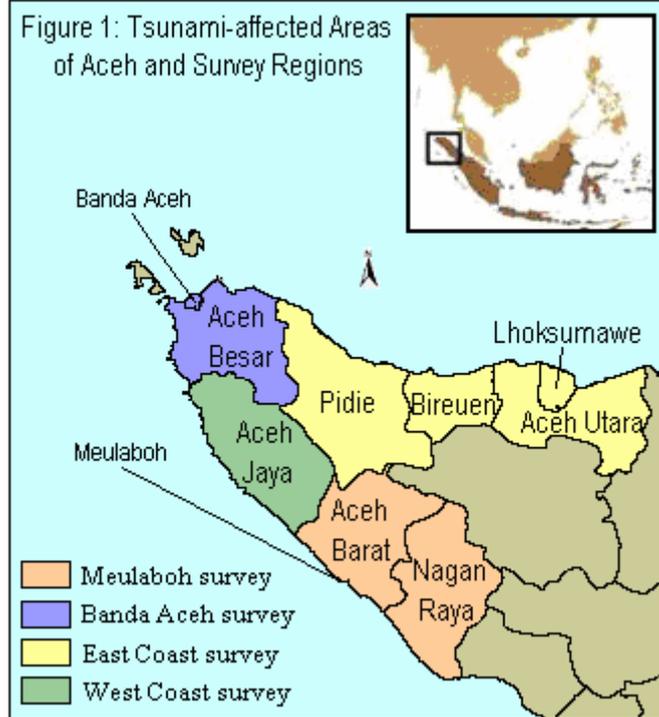
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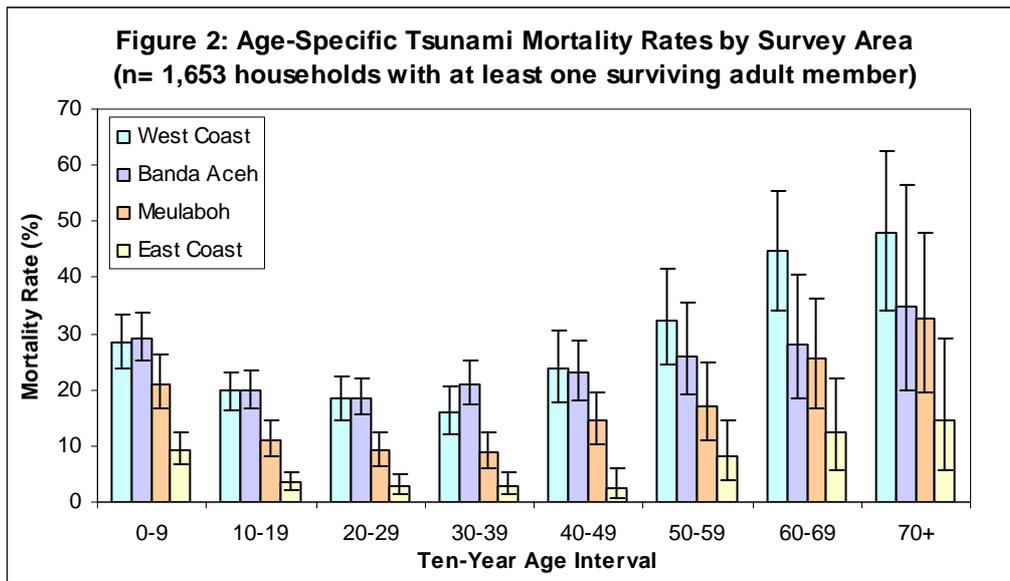
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Figure 1: Tsunami-affected Areas of Aceh and Survey Regions





**Table 1: Crude Mortality and Female Relative Risk by Survey Area**

Area	Crude Death Rate	Female Relative Risk
West Coast	23.6	1.6
Banda Aceh	22.9	1.2
Meulaboh	13.9	2.1
East Coast	5.3	1.5

**Figure 3: Age and Sex Specific Mortality Rates  
Among Tsunami-Displaced Households**

