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Population Size Estimates of Street Children in Iran: Synthesis of Multiple Methods

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Abstract We used four methods (direct count, indirect count, wisdom of the crowd, and unique object multiplier) to map and estimate the population size of street children in six major cities in Iran in 2017. In aggregate for the six cities, the number of street children was estimated at 5296 (interquartile range [IQR] 4122-7071) using the median of the four methods. This corresponds to a rate of 16.3 (IQR 12.5–24.5) per 10,000 children age 5–18 years old, or 3.2 (IQR 2.4–5.3) per 10,000 total population. The total number for street children in the country is estimated at 26,000 (IQR 20,239–34,719) children. Results can help policymakers advocate for resources, plan programs, and evaluate the reach of programs for street children. The maps created through the course of the population size estimation exercise can also guide outreach efforts to provide street children with health and social welfare services.

Keywords Street children · Population size estimation · Iran · Mapping

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Introduction

Worldwide, studies find street children vulnerable to multiple adverse health and social welfare outcomes, including physical violence [1, 2], sexual violence [1, 3, 4], drug use [3, 5–7], smoking [8, 9], lack of education, and extreme poverty [10]. Iran's national HIV strategic plan for 2015–2020 includes street children as one of the key populations at high risk for HIV [11]. Shoghli et al reported 4.5% HIV prevalence among 1000 street children recruited by street-walk sampling (i.e., a non-random selection of venues and recruitment by convenience) in Tehran in 2010 [12]. HIV prevalence was higher (9%) among street children who reported ever using drugs.

A rapid assessment and response study among street children in Tehran in 2012 found street children in dire economic situations, with 29.3% of fathers and 87.8% of mothers unemployed. Of fathers who were employed, the majority obtained income from low-paying employment such as selling flowers or waxing shoes on the street. The study also found that one-quarter (25.5%) of street children in Tehran were girls, 5.8% were between ages 4 to 9 years, and 45.3% were age 10 to 14 years. Street children were from all ethnic and cultural groups

in Iran, including the major immigrant populations of Afghans, Zabolis, Azaris, Loris, and Kurds. Afghans comprised 36.3% of all street children in Tehran [13]. Street children differ in the level and pattern of vulnerability to sexual and drug use-related harm. For example, street girls have higher risk of sexual abuse and alcohol use [14], and alcohol use at younger age [15], while street boys have higher risk for drug use [16]. Iranian street children have significantly higher prevalence of alcohol [16] and drug use [17] compared to Afghan street children, while Afghan street children have lower access to educational and health services.

The number of street children in Iran is not known. The recent economic crisis in Iran may have driven more families to poverty, resulting in more children working and living on the streets. However, no recent study has systematically estimated the number of street children in Iran beyond the capital of Tehran. Knowing the population size of street children is needed for effective advocacy and program planning for this underserved population. Given the absence of a gold standard or bias-free approach [18], we adapted and applied four different methods to estimate the population size of street children in six major cities of Iran. We synthesized the estimates from these four methods to arrive at a robust estimate to better inform health policies and guide research to improve the health and welfare of street children in Iran.

Methods

Overall Approach

We used four methods to estimate the size of the population of street children in six cities in Iran. Multiple methods were used under the assumption that different methods may be prone to different biases, have complementary strengths, provide a more robust central tendency, and suggest possible variation. The use of multiple methods for size estimation has been promoted by UNAIDS for key populations at risk for HIV [18]. Our methods included a direct count [18], an indirect count [19], wisdom of crowd [20], and unique object multiplier [21]. The four estimation approaches were integrated into a rapid assessment and response study conducted from March to May 2017 that included quantitative and qualitative methods. The six cities (Tehran, Mashhad, Karaj, Kermanshah, Zahedan, and Bandar Abbas) were selected from different geographical and ethnic areas to capture cultural variation across Iran. For all locations and parts of the study, street children were defined as under 18 years old and having spent at least a few hours of each day working or living on the street for at least the preceding month.

Steps and Procedures

Field work was conducted in successive, interconnected steps (Table 1) beginning with a qualitative phase that included interviews with key informants and group discussions with street children (Step 1). The purpose of the qualitative phase was to create a list of all potential venues where street children could be found and identify the days and time periods when the maximum number of street children are present. Key informants included diverse persons with knowledge of street children at the city level (e.g., municipal social welfare personnel, public and non-governmental service providers, academicians) and the street or venue level (e.g., street children themselves). In practice, the group discussions with street children corroborated venues named by other key informants and added venues not previously identified in each city. Venues solicited included corners of streets, parks, metro gates, bus stations, shopping malls or centers frequented by street children. Two adjacent venues were considered separate if they were at a walking distance of 5 or more minutes.

The qualitative mapping phase was followed by a quantitative phase conducted at the venues in two visits (steps 2–4). Using an approach similar to time-location sampling (TLS) [21, 22], we prepared a list as the "universe of venues" with days and times for the peak attendance of children according to the key informants and group discussions. We then selected a random sample of venue-day-time periods from the list of all venues for the team to visit during 1 week. This first visit accomplished several activities. First, staff verified the presence of street children. Second, staff made an initial count of street children present in a 1-h period. Third, local key informants were interviewed at the venues on their estimates of the number of children present in a 24-h period. Fourth, children present were systematically approached and given a bracelet (unique object).

Venues with three or more street children in the first visit were visited a second time over the next

Table 1 Study steps and methods to estimate the population size of street children in six cities in Iran, 2017.

Step 1	Interview key informants to create a list of venues where street children will be found and dates and times when maximally present
Step 2	Visit venues (visit 1) to verify presence of street children, and count all street children observed for 1 h (direct count method)
Step 3	Interview local key informants at venue (visit 1) for their estimate of the average, minimum, and maximum number of street children present in the venue in a 24-h period (Indirect count method)
Step 4	Distribute bracelets to the street children in each venue (visit 1) (unique object multiplier method)
Step 5	Revisit venues (visit 2) at 1 to 5 weeks after visit 1, count street children observed in 4 h (direct count method)
Step 6	Interview street children in each venue (visit 2) on the number of peers present in 24 h (wisdom of the crowd method) and whether they received the bracelet (unique object multiplier method)
Step 7	Calculate the street children population size in each venue by all methods, including median and interquartile range; extrapolate the calculation for all other venues and for a city-wide population size estimate (Synthesis and extrapolation)

5 weeks at a randomly selected day-time period (Step 5). In total, 26 venues were visited only once because they had three or fewer street children on the first visit or the venue was identified only during the second round of visits. This second visit accomplished several activities. First, staff counted the number of children appearing in the venue over a 4-h period to verify counts. Second, a brief interview was conducted with children who were systematically approached to gather a minimal amount of data to verify living on the street, duration of being on the street, and demographic background. Third, for size estimation purposes, the intercepted children were asked to estimate the number of street children they knew in the venue and whether they had received the bracelet (Step 6).

Methods to Calculate the Number of Street Children (Step 7)

Direct Count

The direct count method [18] used the number of street children in each venue counted in the 1-h period (visit 1) and the incremental number appearing in the 4-h period (visit 2) to estimate the total number of street children present in a 14-h day in each venue (Eq. 1). Our method is using a differential approach, not a ratio as suggested in the reverse tracking method [23]. The reason for extrapolating the counts to 14 h per day was that most street children were present in the locations from 8 a.m. to 10 p.m. based on the formative assessment.

$$\begin{aligned}&\text{Total no.in 14 h in each venue}\\&\quad=\text{total no.in 1–h visit}\\&\qquad+[(\text{total no.in 4–h visit}-\text{total no.in 1–h visit hour})\times 13/3]\end{aligned}\tag{1}$$

The mean was calculated for the visited venues and applied to the other venues in each city. The sum of all venues estimated the total number of street children. For those venues that were visited only once, we used the average counts for the 1-h visits and the 4-h visits for venues that were visited twice and calculated the difference between the two to generate the incremental increase in the number of children from 1 to 4 h. We then extrapolated the number estimated to 14 h.

Indirect Count

The indirect count method [19] used the responses of the local key informants interviewed at each venue during visit 1. Informants were asked to report their best estimate and the minimum and maximum number of street children they see in a typical 24-h day in the venue. The mean of the responses was calculated for the visited venues and applied to the other venues in each city. The sum of all venues estimated the total number of street children.

Wisdom of Crowd Method

The wisdom of the crowd method [20] used the responses of children interviewed on the second visit

when asked to recall the total number of street children who work/hang-out in the same venues as they do in a 24-h period. We averaged the responses for each venue visited and applied the average to the other venues in each city. The sum of all venues estimated the total number of street children.

Unique Object Multiplier

The unique object multiplier method [21] calculates the total number of street children (N) using the number of bracelets distributed (n) in visit 1 divided by the proportion of children reporting receiving a bracelet in the brief interview during visit 2 (Eq. 2).

$$N = \mathrm{n}/\mathrm{p} \tag{2}$$

In this method, the estimate calculates the number of children in the whole city, not within each venue. We also calculated the 95% confidence interval using the delta method described by Johnston et al. [21].

Synthesis and Extrapolation

After estimating the total number of street children for each city by each method, we calculated the median and interquartile range (IQR, 25th and 75th percentiles) of the four estimates in each city. The median was held to be the "best estimate" and the IQR as the plausible range [20, 22]. This best estimate was then used to calculate the rate of street children per 10,000 total population and per 10,000 children age 5–18 years in each city. Finally, a combined six city estimate population rate was applied to the total population in Iran in 2018 for a national estimate of the number of street children. We also calculated the population size estimates based on the mean of the four methods, with 95% confidence intervals. Because the mean estimates were similar to those generated by the medians, we decided to use the final synthesized population size based on the medians as less influenced by the effects of outliers.

Ethical Considerations

The study protocol was reviewed and approved by the ethics committee of the University of Welfare and Rehabilitation Sciences in Tehran on 21th February 2017 (ethics Approval number CODE IR.USWR.REC.1395.373). Informed consent was verbally obtained from all children before data collection, with the determination that they could consent for themselves as they were emancipated minors living on the streets. We did not collect any personally identifying information; study forms and questionnaires were linked using a unique code. Participants with identified health and acute social welfare needs were referred to collaborating non-governmental organizations and, if needed, were subsequently referred to governmental facilities in each city. Of note, field team staff were enlisted from local non-governmental organizations working wholly or in part with street children in each city. They were trained together in Tehran on the aims, methods, and techniques of the study for sensitization and standardization. Street children attending group discussions received food and refreshments. Street children interviewed at venues received 50,000 Rials (US$1.35) for their time.

Results

Key informants and group discussants identified 370 venues (range 23 to 113 per city) where street children were purportedly present (Table 2). Interviews with street children in the field identified an additional 94 venues (range 4 to 32 across cities). Of the 464 total venues, our team visited 226 (48.7%) at the randomly selected venue-day-times for the 1-h counting periods (visit 1), and 200 venues (43.1%) for the 4-h periods. Our team interviewed 114 key informants with knowledge of street children at the city level, 223 key informants with local or neighborhood knowledge, and 933 street children with venue-level knowledge. Street children interviewed had a mean age of 13.8 years (SD ± 2.3); 9.8% were girls; 53.9% were born in Afghanistan or had Afghan ethnicity; 11.9% had never attended school.

Direct Count Estimates

During the 1-h observation periods at the venues in the six cities, we counted 53 to 709 street children per city, or 3.4 to 10.6 children per venue per city on average (Table 2). Additionally, we counted 320 to 2364 street children in the sub-sample of venues during 4-h periods to generate incremental numbers of children, ranging from 7.1 to 16.3 per venue per city. Applying these

Table 2 Direct count, indirect count, and wisdom of the crowd methods to estimate the number of street children in six cities of Iran, 2017

City	Bandar Abbas	Zahedan	Kermanshah	Karaj	Mashhad	Tehran
Number of venues reported by key informants	31	23	47	45	111	113
Number of additional venues reported by street children	11	4	5	13	29	32
Number of venues visited by study team (visit 1)	21	21	32	25	51	76
Number of street children counted in 1 h in all venues visited by study team (visit 1)	53	201	142	166	92	709
Average number of street children counted per venue in 1 h by study team (visit 1)	3.9[a]	9.6	4.4	6.6	3.4[a]	10.6[a]
Number of street children projected for all venues in a 1-h period by counts	164	259	229	383	476	1537
Number of venues visited by study team (visit 2)	21	19	23	25	50	62
Number of street children counted in 4 h in all venues visited by the study team (visit 2)	125	223	163	238	176	881
Average number of street children in 4 h in all venues according to counts by study team	8.3[a]	11.7	7.1	9.5	5.9[a]	16.3[a]
Number of street children projected for all venues in a 4-h period by counts	349	320	369	551	826	2364
Average number of street children in 14 h in all venues according to counts by study team	22	18	12	19	12.4	33
Number of street children projected for 14 h in all venues according to counts by study team (Direct count method, six city total = 9657)	*924*	*486*	*624*	*1102*	*1736*	*4785*
Number of street children in 4 h in all venues as estimated by local key informants (visit 1)	277	378	250	499	476	1711
Average minimum, maximum number of street children in 24 h per venue as estimated by local key informants (visit 1)	7.8, 11.9	6.5, 15.5	3.2, 4.8	3.0, 8.7	2.8, 5.3	6.5, 13.0
Minimum, maximum number of street children in 24 h in all venues as estimated by local key informants	328, 500	176, 419	166, 250	174, 504	392, 742	943, 1885
Number of street children in 24 h in all venues as estimated by local key informants (Indirect count method, six city total = 3240)	*414*	*298*	*208*	*339*	*567*	*1414*
Average number of street children per venue as estimated by street children (visit 2)	8.6	14.2	5.0	17.3	8.4	15.5
Number of street children in all venues as estimate by street children (Wisdom of the crowd method, six city total = 5431)	*362*	*383*	*260*	*1003*	*1176*	*2247*

[a] Removing venues with no street children present

averages, we estimated the total number of street children at the venues in a 14-h turn-over period for all six cities at 9657. These direct count estimates ranged from 486 in Zahedan to 4785 in Tehran.

Indirect Count Estimates

Through the 223 local key informant interviews, the number of street children at the venues in 24-h periods was also estimated using the indirect count method. This method produced estimates of street children ranging from 208 in Kermanshah to 1414 in Tehran (Table 2). The total number of street children for all six cities using this method was 3240.

Wisdom of the Crowd Estimates

Of the 933 street children key informants, 856 (91.7%) answered the wisdom of the crowd question. Using this method, the number of street children was estimated at 5431 for all six cities (Table 2). By city, the estimate ranged from 260 street children in Kermanshah to 2247 in Tehran.

Unique Object Multiplier Estimates

A total of 941 bracelets were given to street children (Table 3). Of the 933 street children later interviewed, 3.7% to 75.0% in the different cities reported that they received the bracelet. The unique object multiplier method estimated the total number of street children in the six cities at 5258. The estimate ranged from 100 in Kermanshah to 1933 in Tehran. Upper and lower 95% confidence limits are also shown in Table 3.

Synthesis and Extrapolation of Estimates

The median of the four methods used to estimate the number of street children in the six cities ranged from 234 (IQR 181–351) in Kermanshah to 2090 (IQR 1803–2882) in Tehran (Table 4). The combined median number of street children for all six cities was 5296 (IQR 4122–7071). This corresponds to a rate of 16.3 (IQR 12.5–24.5) per 10,000 children aged 5–18 years old, or 3.2 (IQR 2.4–5.3) per 10,000 total population. Applying the median rate to the total population of Iran in 2018 (81,142,994 persons) extrapolates the total number of street children nationally to 26,000 (IQR 20,239–34,719).

Discussion

We estimate there are over 5000 street children living in six cities within diverse regions of Iran through triangulation of several size estimation methods. Extrapolating the population rates, we estimate there are 26,000 street children in the country in 2018. This translates to per-capita rates of 16.3 per 10,000 children age 5 to 18 years or 3.2 per 10,000 total population. Internationally, there are few studies against which to compare our estimate. Three cities in northeast Brazil found higher rates, including 31.5 per 10,000 population in Aracaju, 57.8 in Maceió, and 59.5 in Arapiraca [24, 25]. Another study to estimate the number of young (13 to 17 years old) homeless children in seven cities in Cambodia yielded a total estimate of 2697 [26].

To our knowledge, the present study is the first to triangulate estimates from different approaches to arrive at robust numbers of street children in Iran, also producing notable variation by method. Among all methods, interviews with local key informants produced the lowest estimates. It is possible that informants overlooked in- and out-migration of street children in the venues leading to underestimation. The highest estimates resulted from the observed counts in 1- and 4-h visits with extrapolation of these numbers to the full day. It is possible that this extrapolation led to an overestimation if a fixed number of children simply circulated in and out of the venues without being recognized by the counters. We also used the incremental difference between the counts in 1-h and 4-h visits to extrapolate the number to a full day. Since the identified venue-day-times were selected for the maximum number of street children to be present, the extrapolation from the visit time to the full day might have led to an overestimation of the street children. The wisdom of the crowd and unique object multiplier methods tended to produce

Table 3 Unique object multiplier method to estimate the population size of street children in six cities in Iran, 2017

City	Bandar Abbas	Zahedan	Kermanshah	Karaj	Mashhad	Tehran
Number of bracelets distributed to street children	50	65	75	130	208	413
Number of street children interviewed	54	50	64	91	206	468
Number of street children reporting receiving a bracelet	2	25	48	11	64	100
Proportion of street children reporting receiving a bracelet—point estimate (P)	3.7%	50.0%	75.0%	12.1%	31.1%	21.4%
Frequency of street children reported receiving the bracelet—lower 95% confidence limit (LL P)	0.5%	35.5%	62.6%	6.2%	24.8%	17.7%
Frequency of street children reported receiving the bracelet—upper 95% confidence limit (UL P)	12.7%	64.5%	85.0%	20.6%	37.9%	25.4%
Point estimate of population size (Unique object multiplier method, six city total = 5258)	*1350*	*130*	*100*	*1075*	*670*	*1933*
Lower limit of population size	392	101	88	631	549	1628
Upper limit of population size	11,069	183	120	2100	838	2328

Table 4 Summary and synthesis of the population size of street children estimated by several methods in six cities of Iran, 2017

City	Direct count method (study team)	Indirect count method (key informants)	Wisdom of the crowd method (street children)	Unique object multiplier method	Mean of all methods (95%CI)	Median of all methods (IQR)	Street children per 5–18 years old, and per 10,000 total population
Bandar Abbass	924	414	362	1350	763 (306, 1220)	669 (401, 1031)	41.2, 9.8
Zahedan	486	298	383	130	325 (177, 472)	341 (256, 409)	16.0, 5.1
Kermanshah	624	208	260	100	298 (76, 521)	234 (181, 351)	10.7, 2.2
Karaj	1102	339	1003	1075	880 (525, 1236)	1039 (837, 1082)	27.3, 5.3
Mashhad	1736	567	1176	670	1038 (512, 1564)	923 (644, 1316)	12.0, 2.7
Tehran	4785	1414	2247	1933	2595 (1125, 4065)	2090 (1803, 2882)	13.9, 2.3
Total	9657	3240	5431	5258	5899 (2721, 9078)	5296 (4122, 7071)	16.3, 3.2

intermediate estimates compared to the direct and indirect count methods.

Our data also point to variations in street children across the different cities. Bandar-Abbas and Karaj had the highest per-capita rates of street children. Bandar-Abbas is port city in the south of Iran with high seasonal tourism (particularly during winter, New Year, and spring), potentially attracting street children from other areas. Since our data collection in Bandar-Abbas was in spring, we believe our estimate may be high relative to the entire year. Karaj is a city with a high percentage of Afghan street children (76.7%) [17] and is also home for many internal immigrants, including poor families and minorities. At the lower end of estimates, Kermanshah had the lowest per-capita rate of street children. Among the six cities studied, Kermanshah is notably the only one from which Afghan immigrants are barred by law.

Our median finding suggests 2090 street children in Tehran, which is less than half of the estimated number in a study conducted in 2012 (5479 children) [13]. Our range according to different methods (1414 to 5119) also falls below the prior estimate. Given the magnitude of the difference combined with a worsening economic trend, we believe the difference is methodological rather than real (i.e., either the current estimate is biased downward or the previous estimate upward).

We estimated the number of street children only in public and street-based venues. Street children who were temporarily at institutions or shelters, or who were working indoors were not included in our counts. To our knowledge, there is no study that has directly estimated the number of these populations. Nonetheless, expert opinion estimates about two million working children live in Iran [27]. Street children (who work or live on the street) are evidently only a small portion of all vulnerable children in Iran [28].

Our study has other limitations. Our methods did not account for in- and out-migration. Our findings from the formative assessment indicated that street children have territories (for business) in streets and only one third moved from one venue to another over a period of 1 month. Since we collected data from each city in about a month, we do not expect our results to be severely affected by movement in or of areas or by double counting. In addition to missing working and temporarily institutionalized children, we may also underestimate children who spend more time indoors (e.g., clubs, squats). Due to safety issues, we did not visit some venues in Zahedan and Mashhad. Moreover, we only

did the mapping and size estimation exercise in six major urban areas in Iran. The generalization to other urban areas and to rural settings in Iran should therefore be interpreted cautiously.

Despite these limitations, we were able to use several methods to estimate the size of street children. We believe our estimates can be used as a foundation to improve upon, develop new methods, and to conduct inclusive research with street children. Meanwhile, our estimations can be used to advocate and plan for services to improve health and reduce vulnerability of street children in Iran.

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