Defining the urban area for cross national comparison of health indicators: the EURO-URHIS 2 boundary study

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Introduction: Despite much research focusing on the impact of the city condition upon health, there still remains a lack of consensus over what constitutes an urban area (UA). This study was conducted to establish comparable boundaries for the UAs participating in EURO-URHIS 2, and to test whether the sample reflected the heterogeneity of urban living. Methods: Key UA contacts (n = 28) completed a cross-sectional questionnaire, which included where available comparison between Urban Audit city and larger urban zone (LUZ) boundaries and public health administration areas (PHAA). Additionally, broad health and demographic indicators were sought to test for heterogeneity of the EURO-URHIS 2 sample. Results: Urban Audit city boundaries were found to be suitable for data collection in 100% (n = 21) of UAs where Urban Audit data were available. The remainder (n = 7) identified PHAA boundaries akin to the ‘city’ level. Heterogeneity was observed in the sample for population size and infant mortality rate. Heterogeneity could not be established for male and female life expectancy. Discussion: This study was able to establish comparable boundaries for EURO-URHIS 2 data collection, with the ‘city’ area being selected for data collection. The homogeneity of life expectancy indicators was reflective of sub-regional similarities in life expectancy, whilst population estimates and rates of infant mortality indicated the presence of heterogeneity within the sample. Future work would trial these methods with a larger number of indicators and for a larger number of UAs.

Methods
A cross-sectional survey was performed during June and July 2009 for the 28 UAs located within the WHO-EURO region. Key city contacts from the EURO-URHIS 2 consortium or participating institutions (n = 28) completed questionnaires for their respective UAs. The study questionnaire was piloted in March 2009 with a sample of participating areas, and a modified version was agreed as fit for purpose by the project steering group. The inclusion criterion was that UAs be European.

Each questionnaire contained the LAU2 areas that make up the Urban Audit LUZ, which were obtained from Urban Audit upon request. Contained within the LUZ is the City area. Respondents were required to indicate which of the LAU2 areas in their respective...
LUZ formed the PHAA of their UA to assess congruency between the LUZ and PHAA. The PHAA was selected for comparison so that the boundaries used in the project were most relevant to urban health policymakers. As not all of the study UAs are represented by Urban Audit, a separate questionnaire was designed asking for details of the sub-city areas that formed their each respective UA PHAA.

The WHO-EURO region contains three sub-regions, categorized on broad adult and child mortality expectancies. EUR-A represents very low adult and child mortality, EUR-B low child and adult mortality, with EUR-C experiencing high childhood but low adulthood mortality. The EURO-URHIS 2 sample should incorporate UAs from each of these sub-regions to reflect the range of health expectancies in Europe.

Heterogeneity was assessed in two ways—by WHO-EURO sub-regions and estimates for key population indicators provided by the study participants. Geographical heterogeneity was assessed by categorizing UAs by their location in north, east, south and west Europe, using the United Nations (UN) definition. Differences between sub-regions have been observed for determinants of health, such as patterns of alcohol consumption and type of alcohol consumed. UAs were also considered by WHO-sub-region. Respondents were asked to return data on the following six indicators:

- Total resident population.
- Total resident population of working age (15–64).
- Infant mortality (annual rate per 1000 births).
- Male life expectancy at birth.
- Female life expectancy at birth.
- Gross Domestic Product (GDP) per capita (€).
- Nationals as a proportion of total population (%), with nationals defined as ‘citizen of the country in which the city is located’.

In addition, total resident population in 2004 for the Urban Audit city areas for each participating UA was collected from the Urban Audit database. For Urban Audit cities where population estimates were not provided (n = 5) local sources were used to return this indicator.

Each indicator was measured against an appropriate regional average. Total resident population was measured using the median population of all UAs returning data for Urban Audit. The median was selected in this case as the mean was sensitive to the influence of the largest UAs in the sample. Total resident population of working age, GDP per capita and nationals as a proportion of total population were all compared with the Urban Audit mean of all UAs where data were available. Life expectancy for males and females, and infant mortality rate (IMR) were compared with UN means for Europe representing the period 2005–2010. Only indicators where a response rate above 50% was observed were analyzed to reduce the potential for response bias.

For eligible indicators, each point estimate was converted into a proportion of the appropriate mean or median with 95% confidence intervals (CIs) to show the variation across the sample of UAs.

**Results**

Questionnaires were completed by all UA contacts from Europe (n = 28). Twenty-one respondents completed the Urban Audit version of the questionnaire, whilst the remaining seven completed the non-Urban Audit version. Total resident population of working age, GDP per capita and nationals as a proportion of total population were all excluded as <50% of UAs returned these indicators. Estimates of life expectancy and IMR were not received for Ankara, Bordeaux, Izmir and Montpellier. UAs from Kuwait and Vietnam were excluded as they were not in Europe. Responses were received for LUZ areas of Merseyside and Greater Manchester rather than the 15 EURO-URHIS 2 UAs that comprise these two regions in order to limit over-representation of the United Kingdom in the findings.

**Selection of boundaries**

Of the cities returning the Urban Audit version of the questionnaire, all (n = 21) reported that they could use the ‘city’ definition to collect health indicators for their UAs, whilst 42.9% (n = 9) stated that they could also use the LUZ definition. Three UAs contacts were unable to complete the LUZ component of the questionnaire. Of the remaining 18, seven UAs reported 100% congruency between the LUZ and PHAA area. For those with <100% congruency, the range was 5% (Koln) to 81.6% (Montpellier).

**Demographic indicators**

Table 1 displays the characteristics of those UAs that returned questionnaires, including WHO and UN sub-regional categorization, population size and the broad mortality expectancy indicators. Population and health indicators are explored in detail below. UN sub-regions were represented in the sample, with the largest number of UAs located in Northern Europe (n = 11, 39.3%), then Western Europe (n = 6, 21.4%), Eastern Europe (n = 5, 17.9%) and Southern Europe (n = 4, 14.3%). Turkish cities were classified as Western Asia (n = 2, 7.1%). WHO classify Turkey as part of the Regional Office for Europe, so all participating areas were from Europe-A (n = 15, 53.6%), Europe-B (n = 9, 32.9%) and Europe-C (n = 4, 14.3%). Both geographical and health-based groupings across the region are all represented in the EURO-URHIS 2 sample.

The total population of participating UAs ranged from 61 897 (Tromsø) to 3 401 573 (Ankara). As a proportion of the Urban Audit median (calculated as 214 185), the range was 0.29–15.88 (figure 1). As CIs for these proportions did not overlap, heterogeneity of population size can be assumed. Looking at the UA population estimates in table 1 it can be seen that the EURO-URHIS 2 sample of cities contains a variety of population sizes across the range, reflecting heterogeneity within the sample.

**Health expectancy indicators**

As with the European averages and the trend observed worldwide, female life expectancy was higher than male life expectancy in all EURO-URHIS 2 UAs (figure 2). Life expectancy for males within the sample ranged from 66.3 years (Siauliai) to 76.6 years (Amsterdam). For females, the range was 75.1 years (Craiova) to 81.7 years (Koln). As proportions of the European mean of 71.4 years, male life expectancy ranged from 0.93 to 1.07, and for female life expectancy the observed range was 0.94–1.03. The CIs for all UAs overlapped for both sexes, indicating homogeneity for these indicators.

The IMRs in the responding UAs ranged from 1.26 (18% of the European mean) in Maribor to 14.67 (214% of the European mean (Craiova)). Heterogeneity was observed in the sample (figure 3).

**Discussion**

The present study found that for those UAs that were also included in Urban Audit data collection, the city area was appropriate for the collection of health indicators. This is the jurisdictional area for the urban centres, which represents a boundary that can also be adopted by those UAs beyond the scope of Urban Audit data collection. As public health administration is often part of the wider jurisdictional activities of local governments, the use of the PHAA of the urban centre is largely co-terminus with the City area. EURO-URHIS 2 aims to generate evidence for urban governance, so collecting data at this level is appropriate for both benchmarking and comparison between UAs.
Figure 1 EURO-URHIS 2 UAs as a proportion of the urban audit median population, with 95% CIs. *denotes UAs responding to the non-urban audit version of the questionnaire.

Table 1 EURO-URHIS 2 UAs by WHO sub-region, country and UN sub-region, with demographic and mortality-based indicators

<table>
<thead>
<tr>
<th>WHO sub-region</th>
<th>Country</th>
<th>UN sub-region</th>
<th>Urban areas</th>
<th>Population</th>
<th>Male life expectancy</th>
<th>Female life expectancy</th>
<th>IMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUROPE A (very low child and very low adult mortality)</td>
<td>France</td>
<td>Western Europe</td>
<td>Bordeaux, Montpellier</td>
<td>70027447467</td>
<td>Not recorded</td>
<td>Not recorded</td>
<td>Not recorded</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>Western Europe</td>
<td>Dusseldorf, Koln</td>
<td>572663969709</td>
<td>75.9</td>
<td>81.62</td>
<td>4.43</td>
</tr>
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<td>The Netherlands</td>
<td>Western Europe</td>
<td>Amsterdam, Utrecht</td>
<td>739104270244</td>
<td>76.6</td>
<td>81</td>
<td>4.12</td>
</tr>
<tr>
<td></td>
<td>United Kingdom</td>
<td>Northern Europe</td>
<td>Birmingham</td>
<td>992400</td>
<td>75.8</td>
<td>80.7</td>
<td>7.89</td>
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<td></td>
<td></td>
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<td>Cardiff</td>
<td>316800</td>
<td>76.2</td>
<td>80.7</td>
<td>4.87</td>
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<td></td>
<td></td>
<td></td>
<td>Glasgow, Liverpool</td>
<td>577700, 444500</td>
<td>71.9</td>
<td>77.9</td>
<td>7.11</td>
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<td></td>
<td></td>
<td></td>
<td>Manchester</td>
<td>443700</td>
<td>75.5</td>
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<td>5</td>
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<td></td>
<td></td>
<td></td>
<td>Maribor, Ljubljana</td>
<td>112558, 267563</td>
<td>71.2</td>
<td>81.2</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>Norway</td>
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<td>521886</td>
<td>76.1</td>
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<td></td>
<td></td>
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<td>Tromso</td>
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<td>76.5</td>
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<td>112558, 267563</td>
<td>71.2</td>
<td>81.2</td>
<td>1.26</td>
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<td>EUROPE B (low child and low adult mortality)</td>
<td>Slovakia</td>
<td>Southern Europe</td>
<td>Bratislava, Kosice</td>
<td>425155, 235006</td>
<td>72.1</td>
<td>77.01</td>
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<td>Bistrita, Craiova, Iasi</td>
<td>81950, 299494, 308843</td>
<td>69.0</td>
<td>76.16</td>
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<td></td>
<td></td>
<td></td>
<td>Iasi</td>
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<td>76.54</td>
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<td></td>
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<td>Skopje, Tetovo</td>
<td>506676, 86464</td>
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<td>77.14</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Izmir</td>
<td>2386759</td>
<td>Not recorded</td>
<td>Not recorded</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>Kaunas</td>
<td>368913</td>
<td>66.8</td>
<td>78.3</td>
<td>6.11</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Siauliai</td>
<td>129037</td>
<td>66.3</td>
<td>77.31</td>
<td>4.6</td>
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<tr>
<td>EU/RE C (high child and low adult mortality)</td>
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<td>Northern Europe</td>
<td>Liepaja, Riga</td>
<td>86476, 735241</td>
<td>67.8</td>
<td>78.3</td>
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<td></td>
<td>Lithuania</td>
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<td>Kaunas, Siauliai</td>
<td>368913, 129037</td>
<td>66.8</td>
<td>77.31</td>
<td>4.6</td>
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</table>
The secondary objective was to establish a sample of UAs that reflected the heterogeneity of urban living. Heterogeneity was observed in both population size and IMR. This suggests that project is considering UAs with varying demographic and child mortality conditions. IMR is sensitive to deprivation, and fluctuates across WHO-sub-regions much more than life expectancy. Heterogeneity was not observed for female or male life expectancy, which again reflects the conditions reported across Europe at the sub-regional level.

When conducting comparative research between UAs, it is important to try and establish common boundaries between cities whilst acknowledging the fundamental differences between them. The problems in defining these areas are a product of the nature of the urban condition; namely that it is constantly evolving. For example, the ‘urban sprawl’ observed in some US and European cities in recent decades has seen the health impact of the traditional inner-city expand to the suburbs.11

There are many features of the environment that can be classed as urban in nature, and classifications of UAs can be based upon information such as morphological (in relation to spatial dimensions such as buildings, streets and industrial zones), administrative or functional UAs.12

Typically the boundaries set by urban projects take a pragmatic approach based on either the availability of data, or the needs of those participating. For example, the WHO Healthy Cities programme allows each city to set its own boundary, which is based on the administrative area. The WHO Healthy Cities not a research programme as their aims are based on health improvement and better health policy. Therefore, having non-contiguous boundaries for the included cities is not a problem. When WHO wished to commence a benchmarking scheme, the variation in boundaries was a major contributing factor to the poor comparability of data.

Similarly, the Quality of Life project in New Zealand 13 collects data within the administrative boundaries of the 12 participating cities. These cities were defined as ‘urban in nature, or are facing high growth on the fringe of UAs’, once more allowing each city partner to determine boundaries using only broad criteria. The Big
Cities Health Inventory selected the administrative boundaries of the 54 largest metropolitan areas in the United States, which was problematic for some areas which lay in two different states.\textsuperscript{14} Although these definitions are appropriate for the objectives of their respective projects, they give little in the way of criteria for defining boundaries or highlighting what it is that makes the area distinctly urban. EURO-URHIS 2 data collection required scientific rigour in all areas, beginning with the boundaries of each UA. In selecting a non-random sample of UAs, it was vital to reduce selection bias by testing for similarities in setting boundaries and for heterogeneity in the sample of UAs.

Recently, the Organization for Economic Co-operation and Development (OECD) classified member countries into sub-national regions that were predominantly urban, intermediate or predominantly rural using local units which were defined differently between countries.\textsuperscript{15} Many European countries were regionalized using groups of LAU2 areas, meaning that they were defined using broadly contiguous criteria of population density. This definition takes into account inconsistencies in population and building density within sub-regions and provides broad categories for defining spatial units. The OECD distinctions have been adopted by the European Commission, which highlights some inconsistencies with the applicability to all LAU2 areas.\textsuperscript{16} LAU2 units are not homogenous, so a village in a small LAU2 area could be misclassified as urban, whilst a city surrounded by countryside in a large LAU2 area could be wrongly defined as predominantly rural. These categories cannot be adopted for urban health research, as the widely used social and environmental determinants of health model suggests that more than population density is required, and predominantly UAs do still contain areas that would be considered rural.\textsuperscript{17}

This study was limited to the UAs selected by the project. This process was led by key contacts from each country who were brought together through previous involvement in EURO-URHIS 1 and to suit the needs of the call (such as the inclusion of UAs in some of the recently acceded member states such as Latvia and Lithuania). A different sample of UAs may have yielded different response rates for each indicator, and may also have found that the City boundaries were not as widely appropriate as suggested by the present findings. A different sample of UAs may also have produced different results in relation to each indicator tested for heterogeneity. The present methodology could be easily implemented across Europe should future urban health studies require it in the future.

The study was also limited by the availability of the excluded indicators. Migrant health is an important component of urban health research.
health, and GDP is an indicator of deprivation. Both of these indicators would have been useful in establishing heterogeneity of included UAs and future work should strive to obtain higher response rates for these indicators. Likewise, other indicators could have been selected for this project, but the nature of this work was as a preliminary stage to the collection of indicators and the method was fit for purpose.

Urban Audit definitions were used as they represented the most comprehensive effort to define urban areas across the EU. The definitions were based on administrative and functional boundaries of the UA, which does not necessarily reflect other indicators of urban such as population and building density, or levels of air pollution. To define areas based on all of these indicators and others would be impossible, and the Urban Audit distinctions were considered to be rigorous enough for adoption by EURO-URHIS 2.

Highlighting the multifarious nature of the urban environment, Urban Audit created a third category to represent the vast areas covered by London and Paris (the Kernel level). This reflects the continuing difficulty in generating a catch-all definition for the UA. Using the City/PHAA definitions means that some areas outside the boundary that display the features of a UA will be excluded, and for other areas, the unavoidable inclusion of non-UAs. LUZ areas have been shown in the present sample to often include large areas beyond the remit of public health decision making, which would decrease the utility of the findings of EURO-URHIS 2.

In this study, the use of LAU 2 codes was only problematic for those where the codes were not available (n = 7). The use of a common terminology for all UAs in the sample would have made the present findings more robust, and urban health research could be enhanced by the wider adoption of such territorial units.

However, this study has demonstrated a methodology that can be applied to all UAs within the EU, using the two questionnaires sent to UA contacts. LAU2 areas are not in use globally, but similar subnational definitions have been applied for projects including countries from several continents. This method could be adopted for the preliminary stage of comparative data collection not just in the health field, but for many other sectors of research and policy. The definition of urban for this type of research should form the basis of scientific reporting to assist the development of a catch-all methodology to define UAs.

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**Conflicts of interest:** None declared.

**References**