**Urban and Regional Planning**
2021; 6(4): 165-173
http://www.sciencepublishinggroup.com/j/urp
doi: 10.11648/j.urp.20210604.18
ISSN: 2575-1689 (Print); ISSN: 2575-1697 (Online)

# Integrating the Quality of Services into Potential Access Measurement and Assessing Spatial Equity Based on Both the *Need* and *Demand* Conceptions

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## To cite this article:

Chengcheng Wu, Neil Adrian Powe. Integrating the Quality of Services into Potential Access Measurement and Assessing Spatial Equity Based on Both the *Need* and *Demand* Conceptions. *Urban and Regional Planning*. Vol. 6, No. 4, 2021, pp. 165-173.
doi: 10.11648/j.urp.20210604.18

**Received**: November 8, 2021; **Accepted**: November 30, 2021; **Published**: December 9, 2021

**Abstract:** Equitable access to services of good quality is important for disadvantaged social groups and one way to evaluate it is through spatial equity assessment. The existing studies disproportionately focus on measuring access/assessing equity reflecting the *equality* and/or *need* conception(s) and barely integrate the quality of services into the process. Thus, this research explores the necessity for integrating the quality of services into potential access measurement and assessing spatial equity based on both the *need* and *demand* conceptions. Using GP practices in Newcastle upon Tyne, UK as a case study, the research demonstrates the inadequacy of neglecting the quality aspect of services when measuring potential access and of neglecting social groups' demands when assessing spatial equity at the city scale. For instance, the result of the spatial equity assessment for GP practices of good quality in the city is different from the result for all GP practices in the city based on the *need* conception. The result of the spatial equity assessment of all GP practices in the city based on the *demand* conception is different from that of all GP practices in the city based on the *need* conception. Through the illustrations of the conceptual framework for spatial equity assessment and the integration of the size and quality of services into potential access measurement for social groups at the city scale, the research develops a more comprehensive spatial equity assessment framework. It contributes to the existing conceptual and empirical studies in better measuring potential access to services and assessing spatial equity. For policy implications, the research illustrates how to apply the assessment framework to provide recommendations on which services that may need increasing size and/or improving quality at the city scale.

**Keywords:** Equity and Spatial Equity Assessment, *Need* and *Demand* Conceptions, Potential Access Measurement, Size and Quality of Services, GP Practices

## 1. Introduction

Equitable access to services of good quality is important for disadvantaged social groups. One way to evaluate whether there is just distribution of services in socio-spatial dimension is through spatial equity assessment, as it can help identify places where services are inequitably provided and provide recommendations on which services that may need increasing size and/or improving quality [25, 26]. Spatial equity can be assessed based on the needs and demands of social groups in relation to *equity*, i.e., the *need* and *demand* conceptions identified by Talen [27].

However, the existing studies do not integrate the *demand* conception into the assessment process, nor do they barely integrate the quality of services into access measurement. This research will explore the necessity for integrating the quality of services into potential access measurement and assessing spatial equity based on both the *need* and *demand* conceptions. To achieve these, the research will start with the discussion on *equity* and *spatial equity* and the quality aspect of services in potential access measurement followed by its research methods. It then will provide illustrations of the conceptual framework for spatial equity assessment and the integration of the size and quality of services into the process,

based on which a more comprehensive spatial equity assessment framework will be developed. A case study of General Practitioner (GP) practices in Newcastle upon Tyne (hereinafter referred to as "Newcastle"), UK will then be used to demonstrate the inadequacy of neglecting the quality aspect of services when measuring potential access and of neglecting social groups' demands when assessing spatial equity at the city scale. After that, the research will discuss the results and provide an illustration of how to identify services which may need increasing size and/or improving quality at the city scale followed by its conclusions.

### *1.1. Equity and Spatial Equity*

The just distribution of services is a significant and challenging goal for planners, as the realization of which can maximize equitable access to those services [27]. To incorporate *equity* into the planning process, Lucy [18] relates the following five alternative concepts, *equality*, *need*, *demand*, *preferences,* and *willingness to pay*. Talen [27] identifies four conceptions of *equity* that are relevant to planning for services: *equality*, *need*, *demand* and *equity defined by market criteria*.

*Spatial equity* focuses on the socio-spatial dimension of *equity*, with an emphasis on determining what factors account for or are associated with spatial variations in service distribution [22]. Geographical analysis of spatial equity requires measurement, where the conclusions of spatial equity assessment are sensitive to how this measurement is conceptualized and calculated [29, 30]. The assessment of spatial equity is helpful for planners and policy makers to identify places where services are inequitably provided and make decisions accordingly to increase service provision and/or upgrade poor-quality services [25, 26]. *Access* can be used as a tool to investigate whether equitable distribution of services has been achieved or not [28]. Thus, potential inequitable access to services caused by the uneven distribution of populations throughout a city and the distribution of services located at discrete point locations [12, 17] can be analyzed and assessed based on conceptions of *equity* [21]. In socio-spatial terms, an inquiry about whether access to services is equitable or not may require an investigation of the existence of a spatial pattern of different levels of access and whether such spatial pattern differs in accordance with spatially defined socio-economic patterns [29].

Out of the four conceptions of *equity* that are relevant to planning for services identified by Talen [27], it is argued that *equity defined by market criteria* is more related to the economic dimension rather than the socio-spatial dimension of *equity.* The measurement of access to services based on this conception could result in a conflict with the *need* conception, such as the conflict between the aggregate provision of services or efficiency and potential beneficiaries who are in greatest need [9, 27]. Besides, some types of services in certain countries are free and available to residents who need them. For instance, the National Health Service (NHS) is a type of service that is universally available in the UK, caring for people based on their needs rather than their ability to pay [11]. *Equality* is conflicted with *need* and *equity defined by market criteria*. Because *equality* describes that everyone should receive the same benefits from services regardless of their socio-economic status or their willingness/ability to pay [27]. In practical terms, the physical limitation makes it impossible to locate services equidistant to their potential users [18].

While *need* describes that each spatially defined disadvantaged social group should receive disproportionately more benefits from services [27]. This is consistent with the idea that "unequals should be treated unequally", meaning that those who need more services should receive more rather than less services [18], which requires the basis for identifying needs for social groups according to their socio-economic status, such as households classified by deprivation [10]. With certain distance thresholds, *equity* can be assessed using a *need*-based approach [21].

*Demand* describes that an equitable distribution of services should be created taking into consideration the number and benefit of potential users, where "active participation in distributive decisions is 'rewarded' by increased user benefit" [27]. This is manifested through the usage of or request for services considering heavy and light users of the services, which requires the identification of social groups with higher and lower rates of usage, such as social groups with higher and lower GP consultation rates classified by age in the context of primary healthcare services [18, 24]. Thus, similarly, with certain distance thresholds, *equity* can be assessed using a *demand*-based approach.

However, the existing studies disproportionately focus on measuring access/assessing equity reflecting the *equality* and/or *need* conception(s) (such as [4-6, 16, 19, 21, 22, 30]. The *demand* conception should not be ignored as it is important to identify what kind of demands placed on the service provision system from the perspective of potential service users [1]. Some people have a propensity to use services more than others, for instance, people of certain characterizations, such as certain age groups, are more likely to use healthcare services as they are more likely to have issues related to health and illness [3]. Thus, the ignorance of the *demand* conception can lead to partial results in spatial equity assessment.

### *1.2. Quality Aspects of Services in Potential Access Measurement*

Regarding the quality of services, some research suggests the necessity for taking into consideration the quality when measuring access to services due to its importance, but few studies have integrated it into access measurement [13, 20, 27, 34]. Rather, they mention the lack of it as a limitation of their studies (such as [2, 14, 32, 33]). To integrate the quality of services into access measurement based on which to assess spatial equity, Smoyer-Tomic et al.'s [25] research firstly measures access without considering the difference in the quality of services (meaning measuring access for all services of a certain type within a city, playgrounds in this case). It then measures access only including the services classified as being

in good quality in the city to examine the difference. After that, it compares the resultant different access patterns with demographic and social needs of the services to assess spatial equity. The research shows a different spatial equity assessment result when the quality is taken into consideration, based on which it suggests that future studies should include the quality into the assessment process.

This research will integrate the quality of services into potential access measurement drawing upon Smoyer-Tomic et al.'s [25] research although spatial equity will be assessed based not only on the *need* conception drawing upon Nicholls's [21] research but also on the *demand* conception identified by Talen [27]. For the size of services, this research will draw upon Wu et al.'s [35] research on how to apply a population weighting technique to measure potential access integrating the size of services at the city scale.

The research demonstrates the inadequacy of neglecting the quality aspect of services when measuring potential access and of neglecting social groups' demands when assessing spatial equity at the city scale. For instance, the result of the spatial equity assessment for GP practices of good quality in Newcastle is different from the result for all GP practices in the city based on the *need* conception. The result of the spatial equity assessment of all GP practices in the city based on the *demand* conception is different from that of all GP practices in the city based on the *need* conception. Through the illustrations of the conceptual framework for spatial equity assessment and the integration of the size and quality of services of a certain type into potential access measurement for social groups at the city scale, the research develops a more comprehensive spatial equity assessment framework.

The research contributes to the existing conceptual and empirical studies in better measuring potential access to services and assessing spatial equity. For policy implications, it illustrates how to apply the assessment framework to provide recommendations on which services that may need increasing size and/or improving quality at the city scale. This could help increase the provision of services to social groups with greater needs and demands to help improve equitable access.

# 2. Research Methods

To demonstrate how to integrate the quality of services into potential access measurement and assess spatial equity based on both the *need* and *demand* conceptions at the city scale, the research will first provide conceptual illustrations. It will then use GP practices[1] in Newcastle as a case study to illustrate how to achieve these for cities at the city scale. To be more specific, potential access to all GP practices in Newcastle will be measured followed by the measurement only including the GP practices classified as being in good quality (i.e., GP practices with 'Good' and 'Outstanding' Care Quality Commission[2] (CQC) ratings) in the city to assess spatial equity based on both the *need* and *demand* conceptions. After that, the research will illustrate how to apply the assessment framework developed though the conceptual illustrations to identify which services that may need increasing size and/or improving quality at the city scale.

The 2011 Census deprivation dataset will be used as a variable to represent social groups based on the *need* conception, as it can be used to measure both the deprived household and non-deprived households. While other deprivation indices, such as *the English Indices of Deprivation 2015* [8] and *the Scottish Index of Multiple Deprivation* [31] can only be used to measure relative deprivation and the extent of deprivation. The 2011 Census age dataset will be used as a variable to represent social groups based on the *demand* conception, i.e., the age groups at 0-4 and over 74 as the heavy user group and the rest age groups at 5-74 as the light user group, as these two groups can represent higher and lower levels of demands for GP practices based on consultation rates [24].

# 3. Conceptual Illustrations

## *3.1. Conceptual Framework for Spatial Equity Assessment*

As mentioned in the Introduction section, *need* describes that each spatially defined disadvantaged social group should receive disproportionately more benefits from services [27]. This requires the basis for identifying the needs for social groups in accordance with their socio-economic status [18]. Deprivation is related to people in need, as it refers to "a lack, or absence, of particular attributes that contribute to some degree of suffering or relative disadvantage" [14]. It, as an indicator of need associated with the use of services, can offer a key source in demonstrating equity of access to services [10]. Thus, needs can be assessed based on the deprived social group (or the deprived household) and the non-deprived social group (or the non-deprived household) with access to services of a certain type.

Drawing upon Nicholls' [21] research, measuring potential access for social groups at the city scale and then using the Mann-Whitney U test in SPSS to analyze spatial equity based on the *need* conception identified by Talen [27], one of the following results would be suggested:

1. a *need-based equitable access* would be suggested when the percentage of the deprived household with potential access is significantly higher than the percentage of the non-deprived household with potential access to all services of a certain type in a city;
2. a *need-based equal access* would be suggested when the percentage of the deprived household with potential access is higher than the percentage of the non-deprived household with potential access to all services of a certain type in a city while the difference is not significant;

[1] The GP practice is included as one of the key local services in the *English Index of Multiple Deprivation (IMD) 2015* [8] and *the Scottish Index of Multiple Deprivation (SIMD) 2012* [31], the potential accessibility of which is measured and used as one of the indictors to assess deprivation.

[2] Care Quality Commission is an independent regulator of health and social care in England, which monitors, inspects, and regulates services to ensure they meet fundamental standards of quality and safety; and publishes performance ratings [7].

3. a *need-based inequitable access* would be suggested when the percentage of the deprived household with potential access is lower than the percentage of the non-deprived household with potential access to all services of a certain type in a city.

*Demand* describes that an equitable distribution of services should be created taking into consideration the number and benefit of potential users [27]. This is manifested through the usage of or request for services considering heavy and light users of the services, which requires the identification of social groups with higher and lower rates of usage [18]. Thus, demands can be assessed based on higher potential frequency of using services of a certain type by a certain social group (or the heavy user group) and lower potential frequency of using services of a certain type by a certain social group (or the light user group).

Drawing upon Nicholls' [21] research and the *demand* conception identified by Talen [27], one of the following spatial equity assessment results for social groups at the city scale would be suggested:

1. a *demand-based equitable access* would be suggested when the percentage of the heavy user group with potential access is significantly higher than the percentage of the light user group with potential access to all services of a certain type in a city;
2. a *demand-based equal access* would be suggested when the percentage of the heavy user group with potential access is higher than the percentage of the light user group with potential access to all services of a certain type in a city while the difference is not significant;
3. a *demand-based inequitable access* would be suggested when the percentage of the heavy user group with potential access is lower than the percentage of the light user group with potential access to all services of a certain type in a city.

### *3.2. Integration of Quality and Size into the Assessment*

Regarding the integration of the quality of services of a certain type into the assessment at the city scale, there are three steps involved. Firstly, services of a certain type in a city are classified into two categories, i.e., all services of a certain type in a city and the services classified as being in good quality of the same type in the city based on relevant quality criteria according to Smoyer-Tomic et al.'s [25] research. Secondly, spatial equity is assessed based on the *need* conception identified by Talen [27] for social groups at the city scale only including the services classified as being in good quality of a certain type drawing upon Nicholls' [21] research as follows:

1. a *need-based equitable access* would be suggested when the percentage of the deprived household with potential access is significantly higher than the percentage of the non-deprived household with potential access to the good quality services of a certain type in a city;
2. a *need-based equal access* would be suggested when the percentage of the deprived household with potential access is higher than the percentage of the non-deprived household with potential access to the good quality services of a certain type in a city while the difference is not significant;
3. a *need-based inequitable access* would be suggested when the percentage of the deprived household with potential access is lower than the percentage of the non-deprived household with potential access to the good quality services of a certain type in a city.

Thirdly, spatial equity is assessed based on the *demand* conception identified by Talen [27] for social groups at the city scale only including the services classified as being in good quality of a certain type as follows:

1. a *demand-based equitable access* would be suggested when the percentage of the heavy user group with potential access is significantly higher than the percentage of the light user group with potential access to the good quality services of a certain type in a city;
2. a *demand-based equal access* would be suggested when the percentage of the heavy user group with potential access is higher than the percentage of the light user group with potential access to the good quality services of a certain type in a city while the difference is not significant;
3. a *demand-based inequitable access* would be suggested when the percentage of the heavy user group with potential access is lower than the percentage of the light user group with potential access to the good quality services of a certain type in a city.

Concerning the integration of the size of services of a certain type into the assessment at the city scale, this research adopts the concept of 'size weighting' introduced by Wu et al.'s [35], incorporating the availability of services into potential access measurement. The 'size weighting' is calculated by dividing the size of each service of a certain type by the total size of the services of the same type in a city.

## 4. Case Study

### *4.1. Introduction to the Case Study*

Newcastle is situated in the North East of England, UK. According to the 2011 Census [23], the city has a population of 280,177, of which 35,910 people are under 5 or over 74 years old; the city has 117,153 households, of which 69,649 are deprived households.

There are 44 GP practices of different qualities in Newcastle (as of October 2017). Figure 1 shows their locations by quality in the city. There are 3 GP practices with 'Outstanding' CQC rating, 39 GP practices with 'Good' CQC rating, 1 GP practice with 'Requires Improvement' CQC rating and 1 GP practice with 'Requires Improvement' CQC rating (as of October 2017). Figure 2 shows the location of the service areas of the 44 GP practices by quality in the city. Here, half a mile is selected as the maximum distance threshold because this is often regarded as the ceiling for elderly walkers and mothers with preschool children [15].

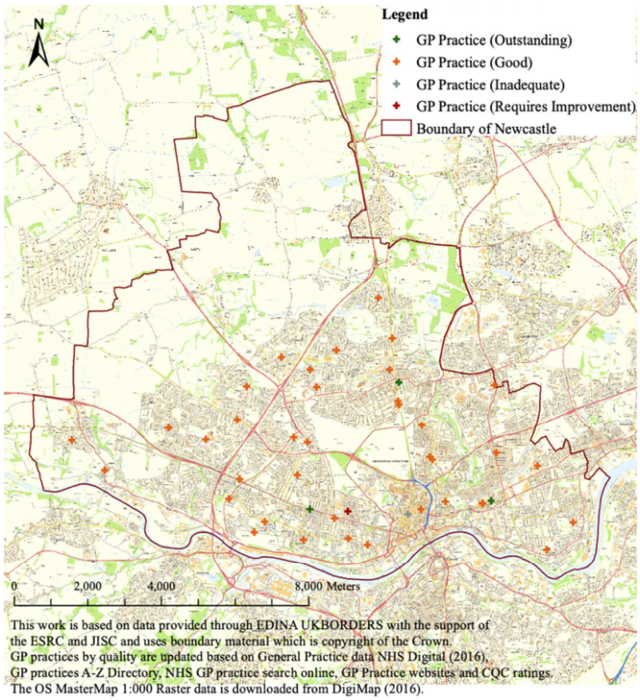


***Figure 1.*** *The location of all GP practices by quality in Newcastle.*

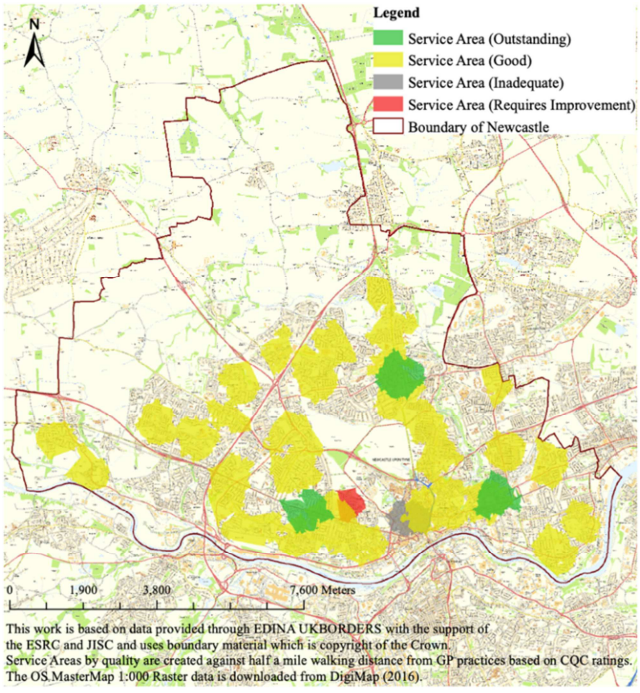


***Figure 2.*** *The location of service areas of all GP practices by quality in Newcastle.*

### *4.2. Potential Access Measurement Integrating the Quality and Size of GP Practices*

To integrate quality into potential access measurement, GP practices in Newcastle were classified into two categories, i.e., all the 44 GP practices in the city and the GP practices of good quality in the city according to the CQC GP performance ratings (i.e., the 42 GP practices with 'Outstanding' and 'Good' CQC ratings). Spatial equity was assessed for the two categories separately for social groups at the city scale based on the conceptual framework (*need* and *demand* conceptions) as illustrated in the previous section, the results of which were then compared to see the difference.

For potential access measurement integrating the size of services at the city scale, the Household Space Weighting (HSW) technique, a population weighting technique was adopted [35]. The size weighting was calculated by dividing the size of each GP practice by the total size of GP practices in Newcastle. Table 1 and Table 2 show the percentages of social groups with potential access to all GP practices and GP practices of good quality in Newcastle respectively calculated applying the HSW technique.

***Table 1.*** *The percentage of social groups with potential access (PA) to all GP practices in Newcastle applying the HSW technique.*

| Conception Assessed | Variable | % of PA |
|---|---|---|
| Need | Deprived household | 1.2441 |
| | Non-deprived household | 1.2216 |
| Demand | Heavy user group | 1.2334 |
| | Light user group | 1.2633 |

***Table 2.*** *The percentage of social groups with potential access (PA) to GP practices of good quality in Newcastle applying the HSW technique.*

| Conception Assessed | Variable | % of PA |
|---|---|---|
| Need | Deprived household | 1.1903 |
| | Non-deprived household | 1.1949 |
| Demand | Heavy user group | 1.2149 |
| | Light user group | 1.2294 |

### *4.3. Spatial Equity Assessment for All GP Practices in Newcastle – Need and Demand Conceptions*

For assessing spatial equity based on the *need* conception for all GP practices in Newcastle, the percentages of the deprived household and the non-deprived household with potential access to all GP practices in the city were compared. According to the above results, the percentage of the deprived household with potential access (1.2441%) is higher than the percentage of the non-deprived household with potential access (1.2216%) to all GP practices in Newcastle. Thus, the SPSS Mann-Whitney U Test was performed to test the difference. The SPSS Mann-Whitney U Tests only report results in a two-tailed manner, so the median values of the percentages of the two groups under comparison were compared by performing the Frequencies to determine whether there is an equitable, equal, or inequitable access based on the *need* conception.

This was achieved by comparing the percentages of the deprived household and the non-deprived household with potential access to all the 44 GP practices in the city with the following null hypothesis: there is no significant difference between the percentages of the deprived household and the non-deprived household with potential access to all GP practices in Newcastle. Table 3 shows the output of the Mann-Whitney U Test for assessing spatial equity based on the *need* conception for all GP practices in Newcastle.

***Table 3.*** *The result of the Mann-Whitney U test.*

| Variable | Median Value of Variable | | Mann-Whitney U Test | 2-tailed p Value |
|---|---|---|---|---|
| | Deprived household with PA | Non-deprived household with PA | | |
| Percent Deprivation | .020800 | .018200 | 939.500 | .812 |

As can be seen from Table 3, the *p* value (Asymp. Sig. (2-tailed)) of the test is .812 (>0.05), so the null hypothesis was accepted. Thus, there is no significant difference between the percentages of the deprived household and the non-deprived household with potential access to all GP practices in Newcastle. This means that even though the percentage of the deprived household with potential access is higher than the percentage of the non-deprived household with potential access to all GP practices in the city, the difference is not significant. Therefore, a *need*-based equal access rather than a *need*-based equitable access was suggested in terms of potential access to all GP practices in Newcastle based on the *need* conception.

For assessing spatial equity based on the *demand* conception for all GP practices in Newcastle, the percentages of the heavy user group and the light user group with potential access to all GP practices in the city were compared. According to the above results, the percentage of the heavy user group with potential access (1.2334%) is lower than the percentage of the light user group with potential access (1.2633%) to all GP practices in Newcastle. Thus, a *demand*-based inequitable access was suggested in terms of potential access to all GP practices in Newcastle based on the *demand* conception.

### *4.4. Spatial Equity Assessment for GP Practices of Good Quality in Newcastle – Need and Demand Conceptions*

For assessing spatial equity based on the *need* conception for GP practices of good quality in Newcastle, the percentages of the deprived household and the non-deprived household with potential access to the 42 GP practices of good quality in the city were compared. According to the above results, the percentage of the deprived household with potential access (1.1903%) is lower than the percentage of the non-deprived household with potential access (1.1949%) to GP practices of good quality in Newcastle. Thus, a *need*-based inequitable access was suggested in terms of potential access to the GP practices of good quality in Newcastle based on the *need* conception.

For assessing spatial equity based on the *demand* conception for GP practices of good quality in Newcastle, the percentages of the heavy user group and the light user group with potential access to the 42 GP practices of good quality in in the city were compared. According to the above results, the percentage of the heavy user group with potential access (1.2149%) is lower than the percentage of light user group with potential access (1.2294%) to GP practices of good quality in Newcastle. Thus, a *demand*-based inequitable access was suggested in terms of potential access to the GP practices of good quality in Newcastle based on the *demand* conception.

## 5. Results and Discussion

Based on the spatial equity assessments for all GP practices and GP practices of good quality in Newcastle in accordance with the conceptual framework (i.e., the *need* and *demand* conceptions), Table 4 summarizes the result.

***Table 4.*** *The result of the spatial equity assessments.*

| Category | Conception Assessed | Variable | Median Value of Variable with Potential Access | Result of Assessment |
|---|---|---|---|---|
| All GP practices | Need | % of deprivation | % of the deprived household (1.2441) is higher than % of the non-deprived household (1.2216) | *Need*-based equal access |
| | Demand | % of age group | % of the heavy user group (1.2334) is lower than % of the light user group (1.2633) | *Demand*-based inequitable access |
| GP practices of good quality | Need | % of deprivation | % of the deprived household (1.1903) is lower than % of the non-deprived household (1.1949) | *Need*-based inequitable access |
| | Demand | % of age group | % of heavy user group (1.2149) is lower than % of the light user group (1.2294) | *Demand*-based inequitable access |

As can be seen from Table 4, the result of the spatial equity assessment for GP practices of good quality in Newcastle (i.e., *need*-based inequitable access) is different from the result of the spatial equity assessment for all GP practices in the city (i.e., *need*-based equal access) based on the *need* conception. This means that even though there could be a *need*-based equal access to all services of a certain type for the disadvantaged social group classified by an indicator reflecting needs in a city, there could be an inequitable access to the services of good quality for the same disadvantaged social group in the city. This indicates a necessity for integrating the quality of services into the assessment framework. Besides, the result of the spatial equity assessment for all GP practices in Newcastle based on the *demand* conception (i.e., *demand*-based inequitable access) is different from the result of the spatial equity assessment for all GP practices in the city based on the *need* conception (i.e., *need*-based equal access). This means that even though there could be a *need*-based equal access to all services of a certain type for the disadvantaged social group classified by an indicator reflecting needs in a city, there could be a *demand*-based inequitable access to the services for the

disadvantaged social group classified by an indicator reflecting demands in the city. This indicates a necessity for including the *demand* conception in the assessment framework.

Figure 3 visualizes the percentage of the disadvantaged social groups in Newcastle and the percentage of the disadvantaged social groups with potential access to each of all the 44 GP practices and the 42 good quality GP practices (i.e., those with 'Outstanding' and 'Good' CQC ratings) in the city. The 2 GP practices with service areas highlighted in green are poor-quality GP practices (i.e., those with 'Requires Improvement' and 'Inadequate' CQC ratings). The darker the color the higher the percentages of the disadvantaged social groups (the deprived household on the left and the heavy user group on the right) in the city on the top two maps and the higher the percentages of the disadvantaged social groups with potential access to GP practices in the city on the bottom two maps.

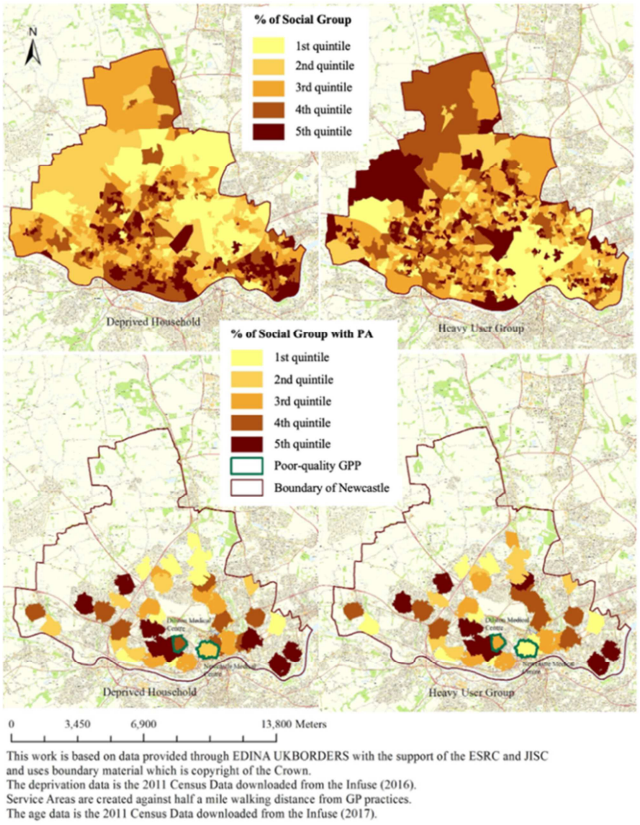


***Figure 3.*** *Visualization of the percentage of the disadvantaged social groups and their potential access (PA) to GP practices (GPPs) in Newcastle.*

As can be seen from comparing the two maps on the left-hand side of Figure 3, the spatial pattern of the top two quintiles (i.e., the 4th and 5th quintiles) of the percentages of the deprived household in Newcastle roughly matches that of the top two quintiles (i.e., the 4th and 5th quintiles) of the percentages of the deprived household with potential access to all GP practices in the city. This reflects the result of the spatial equity assessment based on the *need* conception, that is *need*-based equal access to all GP practices in the city. As can be seen from comparing the two maps on the right-hand side of Figure 3, the spatial pattern of the top two quintiles (the 4th and 5th quintiles) of the percentages of the heavy user group in Newcastle does not match that of the top two quintiles (the 4th and 5th quintiles) of the percentages of the heavy user group with potential access to all GP practices in Newcastle in general. This reflects the result of the spatial equity assessment based on the *demand* conception, that is *demand*-based inequitable access to all GP practices in the city.

The following is an illustration of how to identify which services that may need increasing size and/or improving quality at the city scale. There are six steps involved in the identification process. Figure 4 visualizes the process using the result from the case study as an example. As the identification process has potential to extend to other types of services, it will be presented in a generic way.

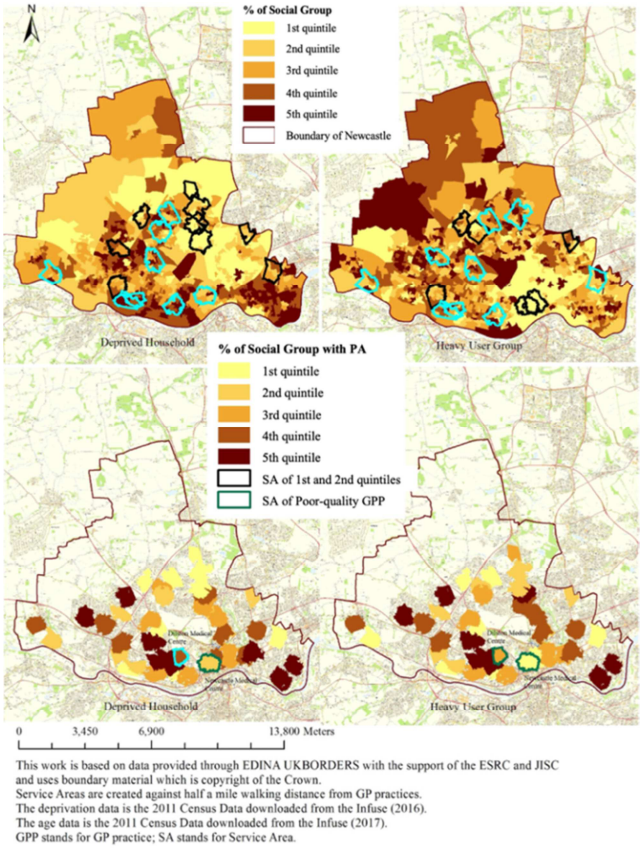


***Figure 4.*** *Visualization of the identification process (PA = potential access; GPP = GP practice).*

First, identify the service areas of the services with lower percentages of potential access for the disadvantaged social groups classified by indicators reflecting needs and demands (i.e., the 1st and 2nd out of the five quintiles) respectively from the bottom two maps of Figure 4. Second, use the two sets of the service areas identified to find the areas with higher percentages of the disadvantaged social groups (i.e., the 4th and 5th out of five quintiles) respectively from the top two maps of Figure 4 (see the highlights). Third, identify the services whose sizes are suggested to be increased by

looking for identical service areas highlighted on the top two maps of Figure 4 (see the six GP practices identified in black in Figure 5).

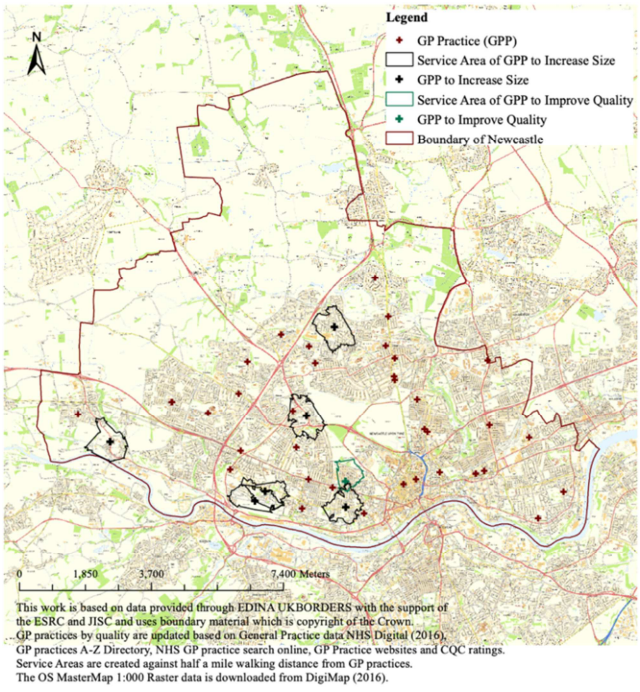


***Figure 5.*** *Visualization of the Result of the Identification Process.*

Fourth, identify the service areas of poor-quality services with higher percentages of potential access for the disadvantaged social groups classified by indicators reflecting needs and demands (i.e., the 4$^{th}$ and 5$^{th}$ out of five quintiles) respectively from the bottom two maps of Figure 4 (see the only one highlighted in this case). Fifth, use the two sets of service areas identified to find the areas with higher percentages of the disadvantaged social groups (i.e., the 4$^{th}$ and 5$^{th}$ out of five quintiles) respectively from the top two maps of Figure 4. Sixth, identify the services whose qualities are suggested to be increased - the identified poor-quality services overlapping with the higher percentages of the disadvantaged social groups classified by indicators reflecting needs and demands (see the GP practice identified in green in Figure 5).

## 6. Conclusions

The research explores the necessity for integrating the quality of services into potential access measurement and integrating the *demand* conception into spatial equity assessment. It draws upon the existing studies, such as the *need* and *demand* conceptions of *equity* that are relevant to planning for services identified by Talen [27], Nicholls' [21] research on combining the assessment of accessibility and distributional equity, Smoyer-Tomic et al.'s [25] research on how to integrate the quality of services into access measurement, and Wu et al.'s [35] research on how to apply a population weighting technique (i.e., the HSW technique) to measure potential access taking into account the size of services at the city scale.

Using GP practices in Newcastle as a case study, the research demonstrates the inadequacy of neglecting the quality aspect of services when measuring potential access and of neglecting social groups' demands when assessing spatial equity at the city scale. For instance, the result of the spatial equity assessment for GP practices of good quality in Newcastle (i.e., *need*-based inequitable access) is different from the result of the spatial equity assessment for all GP practices in the city (i.e., *need*-based equal access) based on the *need* conception. This indicates the inadequacy of neglecting the quality aspect of services and suggests the integration of the quality of services into the assessment framework. The result of the spatial equity assessment for all GP practices in Newcastle based on the *demand* conception (i.e., *demand*-based inequitable access) is different from the result of the spatial equity assessment for all GP practices in the city based on the *need* conception (i.e., *need*-based equal access). This indicates that the ignorance of the *demand* conception can lead to partial results in spatial equity assessment, which suggests the necessity for including the *demand* conception in the assessment framework.

The research contributes to the existing conceptual and empirical studies in better measuring potential access to services and assessing spatial equity. Through the illustrations of the conceptual framework for spatial equity assessment and the integration of the size and quality of services into potential access measurement for social groups at the city scale, it develops a more comprehensive spatial equity assessment framework. For policy implications, the research illustrates how to apply the assessment framework to provide recommendations on which services that may need increasing size and/or improving quality at the city scale. This could help increase the provision of services to social groups with greater needs and demands to help improve equitable access.

For further research, it is worth extending the application of the assessment framework from GP practices to other local or public services. For some service types, different travel modes and distance thresholds may be needed. It may also be worth extending the measurement of potential access to realized access (or the utilization of services) when service usage data is available and compare the results from both measurements. In this case, it may be worth including qualitative analysis of service users by social groups to provide a more holistic view.

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