Equity in access to public dental services: the experience from Norway

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The aim of this study was to identify possible factors associated with the marked geographical variation in supply of public dental services in Norway. We identified three sources for this uneven distribution: differences in dental care needs, differences in revenue levels between counties, and differences in the party composition of the county councils. Analyses were undertaken to ascertain whether these factors were related to the variation in the number of man-labor years of public dental officers. The analyses were performed on a set of data from Norwegian counties for the period 1985–92. There was an association between the number of man-labor years of public dental officers and our indicators of dental care needs, county revenue, and party composition of the county councils. Our findings are encouraging, as they indicate that the county councils seemed to respond to the dental care needs of the local population. On the other hand, there were inequalities in supply of public dental services that were due to differences in revenue between counties. From an equity point of view, this inequality is undesirable. The inequality could most likely be reduced by decreasing the variation in revenue between counties. Differences in party composition of the county councils had only a small effect on the geographical variation in the number of man-labor years of public dental officers. □ *Dental health; dental services; distribution; equity*

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Equity is a focal public policy objective of health care provision, particularly in the Scandinavian welfare state systems. In principle, all citizens are entitled to equitable health care, irrespective of their economic resources, social standing, or geographical location. In Norway, as in several other countries, equity is a major justification for government control over health care provision. Almost the entire health care system is financed by general taxation and is provided and/or produced by health personnel in public institutions. Local governments at the level of municipalities have responsibility for primary health services, and county authorities provide hospital and dental services.

However, public finance and provision of health services do not automatically ensure equity (1, 2). The focus of the present work was to examine the geographical distribution of public dental officers (PDOs) in Norway. In particular, we examine whether equity in access to public dental services has been achieved. Below, we briefly describe the most important characteristics of the public dental services. These are important, as the framework for the analyses is defined by the institutional setup. We also outline the main approaches to the study of distributional issues in dental care. This is important because it is far from clear how equity should be measured. We then present the theoretical framework for the study and present our hypotheses.

The Norwegian dental health services

In Norway responsibility for planning, organizing, and running dental services lies at the county level. This responsibility was assigned to the counties under the 1983 Dental Health Services Act (3). Services provided by public dental services are mainly financed through taxes. According to the Dental Health Services Act, systematic dental care should be provided by PDOs to the following groups of people, in the following order of priority: a) all children aged 0–18 years of age, b) all mentally and physically handicapped people, c) institutionalized and elderly people, and d) 19- to 20-year-olds. The County Dental Officer is responsible for organizing dental services. This includes allocation of dental manpower in accordance with the dental care needs within the county.

Usually, children aged 3–18 years have regular check-ups at the public dental clinic once a year. No children less than 19 years old receive care from private practitioners. Free care is provided for individuals in groups a–c. In 1992 dental care was provided for 738,000 children (national figures). Provision of dental care to individuals in priority groups b–d is only a minor part of production. For example, in 1992 the number of individuals seen in priority groups b and c was 10,500 and 49,400, respectively (4). Fifteen of 19 counties provide subsidized dental care for 19- to 20-year-olds. In these counties a public subsidy scheme covers 75% of the cost of the services provided. People aged 21 years and more meet all costs for dental care themselves. Most dental care for adults is provided by private practitioners: only a small proportion, 6% in 1992, is provided by the public dental services (4).

PDOs receive a fixed salary paid by the county. Private practitioners obtain their income from fees paid by the patients. The PDOs who treat patients aged 21 or more follow a fixed fee schedule, which is determined by the

Table 1. Number of man-labor years of public dental officers (PDOs) per 10,000 individuals aged 1–18 years by county in 1992

County	Number of man-labor years of PDOs per 10,000 individuals aged 1–18 years	Percentage deviation from national average
Vest-Agder	11.9	−38
Østfold	13.2	−31
Aust-Agder	13.5	−29
Oslo	14.6	−24
Oppland	15.4	−19
Møre og Romsdal	15.4	−19
Buskerud	17.0	−11
Hordaland	17.5	−8
Nord-Trøndelag	18.5	−3
Sogn og Fjordane	18.8	−2
Telemark	20.1	5
Hedmark	20.4	7
Sør-Trøndelag	21.2	11
Nordland	24.6	29
Troms	30.3	59
Finnmark	33.0	73
Mean	19.1	100.0

Ministry of Health and Social Affairs. The fees are based on the average time that dentists spend on different prophylactic and treatment procedures.

Approaches to the study of distributional issues in dentistry

The extent to which dental services are distributed equally in accordance with certain criteria has been an important research area in community dentistry. Broadly speaking, the studies can be classified on the basis of how equity has been defined:

Equity in dental health

These studies have examined the relationship between various measures of social position and the distribution of oral diseases. A consistent finding is a negative relationship between social position and oral health (for a review see Refs. 5, 6). One important conclusion that can be drawn from these studies is that reducing inequalities with regard to income is likely to lead to less inequality in dental health. Another finding is that, even though dental health has improved markedly during the past 10–20 years, inequalities in dental health still persist (6).

Equity of utilization

Equity of utilization is best understood as a situation in which patients with equal needs for health care receive equal treatment, in terms of both the volume and the quality of services (7, 8). One implication of this definition is that dental care should be distributed in accordance with need rather than willingness to pay. Thus a dental service has achieved equity if the amount of services rendered correlates with indicators of need and is independent of variables such as income and education. Several studies show conflicting results. One conclusion that can be drawn so far is that even though dental services to a large extent are allocated in accordance with need, inequalities with regard to income and education still persist (for a review see Refs. 9, 10).

Equity of access

Equity of access is best understood as a situation in which people with equal needs have equal opportunity to use dental services (7, 8). It is a supply-side phenomenon: equal access is achieved when patients with the same needs face the same costs of dental care consumption in terms of both time and money. Whereas utilization is a function of both supply and demand, access is a function of supply only (7, 8). Accessibility is often measured as supply of dental services and as out-of-pocket costs for patients when using dental services. One commonly used measure of supply is dentist to population ratio.

There are few studies within dentistry in which equity in access has been examined. However, those studies that exist show that dentists are distributed unevenly across geographical regions (for example, see Refs. 11, 12). This is also the case in Norway. Although manpower levels for PDOs are determined by the county authorities, there are huge variations in the distribution of PDOs between counties (13). For example, the man-labor years of PDOs per 10,000 individuals aged 1–18 years is 73% above the national average in the county of Finnmark and is 38% below the national average in the county of Vest-Agder (Table 1). A stated national policy goal in Norway is that equity in access to dental services should be achieved (3). The figures quoted above indicate that this policy goal has not been fulfilled. However, it can be argued that descriptive figures alone are insufficient evidence for whether equity in access has been achieved. We need to look into the causes of the uneven distribution of PDOs.

Our approach to the study of this uneven distribution is based on the theories of LeGrand (14) and Sørensen (15). They identify two main causes of unequal distribution of public services: First, there are factors beyond the control of the individual patient or the county council. The challenge is to identify these factors and to examine whether they cause inequalities in the supply of public dental services. Inequalities caused by these factors are considered unacceptable (for further discussion, see below). Second, there are factors that arise from autonomous preferences of the individual patient or the local government. These inequalities are regarded as acceptable.

The central concept used to distinguish between acceptable and unacceptable distribution is individual choice (14, 15). People who receive less than others because they have no choice in determining their situation are regarded as being treated unfairly. On the other hand,

Table 2. Variable definitions and descriptive statistics

Variable	Definition	Mean	Standard deviation
D12	Mean number of decayed teeth per individual aged 12 years	0.85	0.15
D18	Mean number of decayed teeth per individual aged 18 years	1.44	0.19
INCOME	County revenues per inhabitant. Includes block grants and local tax revenues (NOK 1992)	13,487	6,566
LABOR	Proportion of labor representatives in the county council	0.38	0.09
CONS	Proportion of conservative and right-wing representatives in the county council. The reference category is the proportion of center representatives	0.28	0.08
GRPBD	Number of individuals in priority groups b–d who received treatment in the public dental services	5,346	3,770
ADULTS	Number of individuals aged 20 years and more who received treatment in the public dental services	9,373	6,498
EXP	Proportion of public dental officers with more than 4 years' work experience	0.92	0.20
SOLO	Proportion of dental clinics with only one public dental officer (as opposed to clinics with several public dental officers)	0.58	0.14
HYG	Number of man-labor years of dental hygienists divided by the number of man-labor years of public dental officers	0.19	0.08
DSA	Number of man-labor years of dental surgery assistants divided by the number of man-labor years of public dental officers	1.13	0.12

if people receive less than others as a result of their own choice, they are not regarded as being treated unfairly. Distributions that are the outcome of factors beyond individual control are generally considered inequitable. Distributions that are the outcome of individual choice are not.

Hypotheses

If we apply the theories of LeGrand (14) and Sørensen (15) to the public dental services, there are three main factors to discuss with regard to whether PDOs are distributed equitably.

Dental care needs

Dental diseases, although preventable, can be viewed as being largely beyond the control of individuals 1–18 years of age. Certainly, once a tooth is decayed, the patient needs professional help to have it repaired. A major role of dental services is to provide appropriate treatment. LeGrand (14) argues that distribution of services in accordance with health care needs can be viewed as 'compensating patients for elements beyond their control'. Thus, an unequal distribution of PDOs that is due to differences in dental health between counties is, from an equity point of view, acceptable. In that case we expect:

H_1: A positive relationship between the need for dental care and the supply of public dental services.

Economic factors

To some extent, central government allocates its grants in a manner that facilitates a more equal revenue distribution. Nevertheless, the distribution of county revenue is biased. For example, some counties are wealthy due to generous government grants (16). The county of Troms has the highest revenue per capita: NOK 19,107 (= GBP 1,500) (1992 figures). The county with the lowest revenue per capita is Østfold, with NOK 10,527 (= GBP 850). The income elasticity determines the extent to which these disparities are reflected in the supply of public services. Previous studies have shown that local government revenue has a strong effect on the distribution of public services (for example, school services) (17, 18). At the county level hospital physicians are distributed unequally in favor of counties with a high revenue (19). For example, in 1997 the percentage of man-labor years of hospital physicians per inhabitant was 32% higher than the national average in the county of Finnmark. At the same time the revenue of the county council in Finnmark was 36% higher than the national average.

There are no studies from Norway in which the distribution of PDOs on the basis of the wealth of the county has been examined. Distribution of county revenue is decided by the central government and is outside the control of the county dental officers. Differences in supply of public dental services caused by differences in county revenue are unacceptable. According to the Dental Health Services Act (1983), public dental services shall be distributed in accordance with need and not in accordance with the financial strength of the provider (the county council). Hence, if equity in access is achieved, we expect that:

H_2: There is no relationship between the supply of public dental services and the revenue of the county.

Differences in the preferences of the county councils

An important justification for local democracy is to

Table 3. Effect of independent variables on the number of public dental officers per 10,000 individuals aged 1–18 years. Natural logarithm of all variables

Variable	Regression coefficient	*t* Value
CONSTANT	0.31	1.10
D12	−0.01	0.28
D18	0.21	6.58*
INCOME	0.28	11.00*
LABOR	0.07	4.51*
CONS	0.07	2.24*
GRPBD	0.01	0.55
ADULTS	0.01	5.21*
EXP	−0.70	8.48*
SOLO	0.13	4.63*
HYG	0.10	3.53*
DSA	−0.27	3.15*
Adjusted R^2	0.68	

* $P < 0.05$.

enable disparities in the preferences of the county councils to influence public resource allocation (20). Differences in supply of public dental services due to differences in the preferences of the inhabitants are meant to improve the effectiveness of resource allocation. Therefore, if the distribution of public dental services varies in accordance with the party composition of the county council, this does not indicate inequality in access. Rather, it may indicate an inequality that the population has chosen to accept—for instance, by giving priority to other areas. Previous research on local politicians' preferences has found that representatives from left-wing parties give most priority to culture and nurseries, whereas representatives from conservative parties give most priority to health services and schooling (18). In that case we expect that:

H_3: There is a positive association between the proportion of conservative representatives in the county council and the supply of public dental services.

Materials and methods

Our analyses were performed at the county level and covered the years 1985–92. There are 19 counties in Norway. In the analyses three counties were excluded because of incomplete data. The variables and data sources were as follows:

Dependent variable

The dependent variable was the number of man-labor years of PDOs per 10,000 individuals aged 1–18 years. The county dental officers report these data to the Norwegian Board of Health by the end of each year. Our data on the number of man-labor years of PDOs per 10,000 individuals aged 1–18 years for each county were obtained from the annual reports published by the Norwegian Board of Health (4).

Explanatory variables

Need, revenue, and preferences are not mutually exclusive. Therefore, each hypothesis must be tested while controlling for the other two main sources of variation. Dental health was measured as the mean number of decayed teeth per individual aged 12 and 18 years at the county level (D12 and D18) (4). Information on county revenues per inhabitant was obtained from Statistics Norway. The figures for each year were deflated by the consumer price index to 1992 NOK. Information about the party composition of the county council was obtained from the Norwegian Social Data Service. In line with previous research on local governments in Norway, we measured party composition as the proportion of labor representatives and the proportion of conservative and right-wing representatives on the county council (18).

Control variables

The choice of control variables was made on the basis of their impact on the explanatory variables. In particular, the effect of revenue is likely to be biased unless appropriate control variables are included. The reason is that the counties with the highest revenue are also the counties with the highest proportion of PDOs with little work experience, the highest number of dental clinics with only one PDO as opposed to clinics with several PDOs, and the highest number of man-labor years of dental hygienists and dental surgery assistants relative to the man-labor years of PDOs.

Information about the proportion of PDOs with little work experience and the proportion of dental clinics with only one PDO as opposed to clinics with several PDOs was obtained from a questionnaire, which was sent from the Department of Community Dentistry, University of Oslo, to all county dental officers. Information on the number of man-labor years of dental hygienists and dental surgery assistants was obtained from the annual reports published by the Norwegian Board of Health.

Supply of PDOs is also influenced by the number of patients seen in priority groups (b–d) and the number of patients 20 years and more. Therefore, we included the following control variables in the analyses: a) the number of mentally and physically handicapped people, institutionalized and elderly people, and 19- to 20-year-olds who received care, and b) the number of adults who received care in the public dental services. We obtained these data from the annual reports published by the Norwegian Board of Health.

The sets of data from each of the sources described above were merged into one large set of data on which the analyses were performed. Variable definitions and descriptive statistics are given in Table 2.

Analyses

We had panel data, as we had the same information about each county for 8 years. Ordinary least-squares regression (OLS) is a potential candidate for analyzing these data. However, in the case of panel data, OLS can lead to biased coefficients. There are two potential problems (21): The first is heterogeneity bias, resulting from heterogeneity among cross-sections. This can be tested by running correlations between the counties, ignoring the regressors. Tests run on our data showed evidence of heterogeneity between counties. For example, for several of the counties the Pearson correlation coefficient for the number of man-labor years of PDOs per 10,000 individuals aged 1–18 years was 0.80 and higher ($P < 0.01$). In this case OLS can lead to biased results. The second potential problem is autocorrelation. This means that successive observations are dependent, to some extent, over time. For example, with positive autocorrelation the second observation tends to resemble or repeat the first observation and hence gives little new information. As a result, the estimates from an OLS regression will be less reliable. Consider the following equation:

$$e_{it} = \rho u_{it-1} + \eta_{it} \quad (1)$$

where i is the number of counties ($i = 1, \ldots, 16$), t is the number of years ($t = 1, \ldots, 8$), u_i is a random disturbance characterizing the ith municipality that is constant through time, e_{it} is an autocorrelated error term, ρ is the autocorrelation coefficient, and η is a stochastic error term assumed to have zero mean and constant variance. In the case of autocorrelation, ρ takes on a high positive or a high negative value. The test most commonly used to identify autocorrelation is the Durban–Watson test. It tests for $\rho = 0$ against the alternatives $\rho > 0$, or $\rho < 0$. The Durban–Watson test takes on a value close to 2 when $\rho = 0$. In the case of positive autocorrelation ($\rho > 0$) the test takes on a value towards 0, and in the case of negative autocorrelation ($\rho < 0$) the test takes on a value towards 4. Our data showed evidence of a first-order autocorrelation.

Therefore, due to heterogeneity bias and autocorrelation, our data were estimated by using a random effect model (in the work of Judge et al. (21) this model is also called an error component model). This is an analysis for panel data, which utilizes both the cross-sectional and the time series variation in the data. The model is specified as:

$$y_{it} = \alpha + \sum_{k=1}^{K} \beta_k X_{itk} + u_i + e_{it} \quad (2)$$

where e_{it} is defined in equation (1), k is the number of explanatory variables ($k = 1, \ldots, 11$), y is the number of man-labor years of PDOs per 10,000 individuals aged 1–18 years, and X is the independent variables. In the analyses the variables were transformed into the natural logarithm, as this gives the elasticities of the independent variables with regard to the dependent variable.

Results

There was a positive relationship between the need for dental care and the supply of PDOs (Table 3). A 1% increase in the mean number of decayed teeth among 18-year-olds was associated with an increase of 0.21% in the number of man-labor years of PDOs per 10,000 individuals. The mean number of decayed teeth for 12-year-olds had no effect on the supply of PDOs.

The regression coefficient for revenue per inhabitant was 0.28 (Table 3). This implies that a 1% increase in revenue per inhabitant leads to an increase of 0.28% in the supply of PDOs. There was also a positive relationship between party composition of the county council and supply of PDOs. Counties with a majority of labor and conservative members in the county council had a slightly higher supply of PDOs than county councils with a majority of members from other parties. However, an elasticity of 0.07 indicates that the effect was small.

Supply of public dental services increased when the number of adults who received care increased (Table 3). The work experience of the PDOs had a negative effect on supply. Furthermore, supply increased when the proportion of dental clinics with only one PDO increased and when the number of man-labor years of dental hygienists relative to the number of man-labor years of PDOs increased. Supply of PDOs decreased when the number of man-labor years of dental surgery assistants increased, relative to the number of man-labor years of PDOs.

Discussion

Our results provide support for H_1. This is encouraging and indicates that county dental officers take dental care needs into account when planning public dental services. In the present study we used only two indicators of dental need, D12 and D18. Treatment of dental caries is not the only reason for visiting the dentist. Diagnostic and preventive services are also important. Such data were not available in the present study. In future studies it will be interesting to examine to what extent supply of PDOs also reflects the need for diagnostic and preventive services.

The elasticity of county revenue per inhabitant with regard to supply of PDOs implies that disparities in the supply of public dental services are less than disparities in county revenue per inhabitant. Nevertheless, our results indicate that rich counties have a higher level of supply of public dental services than poor counties. Thus, our results are consistent with the results from previous studies from Norway, in which inequalities in supply of public services in accordance with differences in county revenue have been identified (17, 18).

In Norway local governments have little influence on municipal revenue. The reason is that the county income tax rate (7%) is the same in all municipalities (22). This rate is determined by the national government. The county council's decision-making problem is allocation of a

fixed amount of revenue to alternative types of services. This system of financing public services at the county level has implications with regard to the interpretation of the effect of county revenue per inhabitant and preferences in access. Personal income and preferences are related. Normally, people with high incomes have higher preferences for dental care than people with low incomes. From that point of view, it could be expected that counties with a high proportion of inhabitants with a high income would raise their tax rate to increase their supply of dental services. However, this is not possible, since the county councils are not allowed to set their own tax rate. In this manner there is no automatic link between the personal preferences for dental care of the inhabitants and county revenue. The effect of county revenue per inhabitant can therefore, to a large extent, be interpreted as an independent effect, when preferences are controlled for.

Our model allows the numerical strength of parties to affect demand for PDOs. This is reasonable since voters elect party representatives for the county councils, and we would expect the composition of these bodies to reflect the preferences of the electorate. Our results show that only a minor part of the disparities in the number of man-labour years of PDOs per 10 000 individuals can be attributed to differences in party composition of the county councils (Table 3). This is in line with previous research on local politicians' preferences, which has found that the party composition of the local government has very little effect on resource allocation within the municipality (23).

An increase in the number of man-labor years of dental hygienists relative to the number of man-labor years of PDOs led to an increase in supply of PDOs. This finding is surprising, even though the effect is small. Studies from the USA have found productivity gains by employing auxiliary personnel (for example, see Refs. 24, 25). In that case it could be expected that the number of man-labor years of PDOs per 10,000 individuals aged 1–18 years would decrease as the proportion of dental hygienists increases. However, dental hygienists in Norway are used differently from how some types of dental auxiliaries are used in the USA. In an extensive study, encompassing 894 dental practices in the USA, Saving (26) classified dental auxiliary personnel into two groups: 'permissive' and 'restrictive'. His results showed that dental auxiliaries who were classified as 'permissive' showed a high degree of substitution with dentists. These auxiliaries were allowed to do simple fillings and to cut cavities. In Saving's study, the 'restrictive' dental auxiliaries were complements to dentists. They were mainly allowed to do dental health education and scaling and polishing of teeth. According to Saving's classification, dental hygienists in Norway have the characteristics of the auxiliaries classified as 'restrictive'; that is, they operate as complements rather than as substitutes for dentists. In that case, an increase in the number of man-labor years of dental hygienists would also lead to an increase in the number of man-labor years of PDOs. Our findings imply that dental hygienists are not used much for screening for dental diseases. Rather, they give dental health education to children who have already been seen by a dentist and/or they carry out dental health education for groups of children outside the dental clinic (for example, in nurseries and school classes). The number of man-labor years of dental surgery assistants relative to the number of man-labor years of PDOs had a negative effect on the supply of PDOs (Table 3). The elasticity was −0.27. This is a plausible result. An increase in the proportion of dental surgery assistants is likely to improve productivity. Hence, the number of PDOs can be reduced.

Most of the effects of the other control variables were as expected (Table 3). For example, supply of public dental services increased when the number of adults who received care increased. Supply also increased when the proportion of dental clinics with only one PDO increased. This is most likely due to economies of scale in practices in which there are several PDOs. County dental officers compensate for the lack of efficiency in clinics with only one PDO by increasing the supply (for a further discussion on economies of scale in dentistry, see Refs. 27–29). The negative relationship between the work experience of the PDOs and supply is also consistent with other studies (30, 31).

One limitation of the present study is that the data are from several years ago. This raises the question of whether the results are valid at the present time. Obviously, it is difficult to draw conclusions after 1992. However, there is reason to believe that the situation today may not be very different from the situation during the period 1985 to 1992. First, the uneven geographical distribution of PDOs on the basis of county is the same today as it was during the period 1985–92 (32). Second, the distribution of the explanatory variables in accordance with county is also nearly the same (33, 34). Third, the values of the control variables are not likely to have changed very much. On the other hand, since our data only cover the period 1985–92, it is not possible to make definitive conclusions.

In conclusion, we found that there is a relationship between dental care needs and supply of PDOs. This finding is encouraging. The county dental officers should continue to take the dental care needs of their population into account when planning future supply. However, we identified undesirable inequalities with regard to county revenue: rich counties can afford a higher level of supply than poor counties. This inequality can be eliminated by reducing inequalities between counties with regard to revenue. At present there is a debate in Norway about how to remove the present disparities in income level between counties (16).

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