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ORIGINAL ARTICLE

Does subsidized orthodontic treatment reduce inequalities in access? Evidence from Norway based on population register data

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Abstract

Objective: An important part of Norwegian welfare policy is to provide subsidized orthodontic treatment for children and adolescents. The objective of this policy is that dental services should be allocated according to children's need for treatment, and not according to parents' ability to pay. The probability of receiving orthodontic treatment independent of parent's household income was examined.

Methods: The study population encompassed children and adolescents aged 10–18 years in 2019 ($n = 354\,439$). Information about whether they had started orthodontic treatment was obtained from the Norwegian Health Economics Administration. The key independent variable was net equalized household income. Inequalities were measured using concentration indices, which were estimated according to the severity of the malocclusion (very great need, great need, obvious need and no need). Two indices were used to measure relative inequality: the unstandardized concentration index and the partial concentration index. Absolute inequality was measured using the corrected concentration index. Relevant control variables were included in some of the analyses.

Results: The unstandardized indices were in the range 0.04 (very great need) to 0.05 (obvious need). For all three groups of severity, the 95% confidence intervals overlapped. The values of the partial indices were significantly lower than the values of the unstandardized indices. The partial indices were in the range 0.008 (very great need) to 0.03 (obvious need). The 95% confidence intervals for the partial indices did not overlap with the 95% confidence intervals of the unstandardized indices. For all three groups of severity, the indices that measured absolute inequality were close to zero.

Conclusions: It is possible to achieve the egalitarian aim of equality in service provision by subsidizing orthodontic treatment. This is possible within a system where the cost of orthodontic treatment is reimbursed according to the criteria of need. These criteria function in such a way that patients with the greatest need for orthodontic treatment are given the highest priority.

KEYWORDS
inequality, need, orthodontic treatment, parental income, reimbursement

1 | INTRODUCTION

During the last decades, several articles and policy documents have addressed the differences between the market-based dental care systems in several European countries and the publicly funded Scandinavian dental care system.[1–8] Several policy makers have emphasized the advantages of the Scandinavian system. In particular, they argue that this system secures equality in access to dental services. However, there is a lack of research where this has been examined.

The focus of the present study was to examine inequalities in access to orthodontic services for children and adolescents in Norway. Subsidized orthodontic treatment is an important part of Norwegian welfare policy. Does everyone who needs treatment receive it, independently of parents' income? We examined our research question using a large and unique set of population register data, encompassing about 350 000 children and adolescents aged 10–18 years.

In Norway, one health policy goal for orthodontic services is that they shall be distributed according to need, and not according to financial resources such as income.[9] Another health policy goal is that services for children and adolescents shall be given priority over services for adults. In order to achieve this, the state provides reimbursement for orthodontic treatment for children and adolescents, but not for adults.[10] The amount that is refunded varies according to the severity of the malocclusion.[11,12] The need for treatment is classified into four groups, A—very great need, B—great need, C—obvious need and D—no need. The amount reimbursed is 100 per cent of the cost for group A, 75 per cent for group B and 40 per cent for group C. The percentage reimbursed is the same regardless of the parents' income level. Access to the subsidy scheme is available to all immigrants with a residence permit.[13]

In Norway, all individuals 3–18 years of age are regularly recalled to the public dental clinic for a dental check-up. The recall interval varies. Individuals with a high risk for developing caries will usually have a check-up at least once a year. The recall interval for low risk individuals can be from 1 to 2 years.[14,15] The attendance rate is very high. At the national level, less than 1% of children and adolescents aged 3–18 years did not attend public dental clinics for a regular dental check-up.[16] As part of the check-ups, the need for orthodontic treatment is assessed by an orthodontist. With frequent recall intervals and a high attendance rate, nearly all children and adolescents will have the opportunity to be assessed for their need for orthodontic treatment.

Orthodontists classify patients into groups A–D according to detailed clinical and radiographic criteria laid down in the National Insurance Act.[11,12] On the basis of these criteria, patients are classified into mutually exclusive groups. For example, patients with cleft lip/palate are classified into group A, patients with an overjet of 9 mm or more are classified into group B, patients with an overjet of 6–9 mm are classified into group C and patients with an overjet of less than 6 mm into group D. For a comprehensive overview of all the criteria used for classification see Table 2 in Ref. [17]. Most children and adolescents start orthodontic treatment at age 12. At this age, about 90% are classified in group D. Less than one per cent are in group A. The rest are divided about equally between groups B and C.[18,19] Very few children have orthodontic care provided privately. In a study by Grytten et al., sixty per cent of all orthodontists reported that they had only treated children with reimbursement from the Norwegian Health Economics Administration.[20] 40% had treated patients without reimbursement, but on average only 2.6 such patients per year.

In our study, inequalities were examined according to parents' income and the severity of the malocclusion. Ideally, these inequalities should be small, in particular for children with the greatest need for orthodontic treatment. If that is the case, the subsidy scheme has come a long way to redistribute resources so that orthodontic services are accessible to everyone independently of their social status. Previous studies have shown that orthodontic services are evenly distributed across the country, and that waiting lists for treatment are short.[20,21]

There are few studies in which access to orthodontic services have been examined. Vieira et al. give a comprehensive summary of the main findings from these studies.[22] Most of the studies have been carried out in the USA, and fairly large inequalities in access to orthodontic services have been found (e.g. see references[23–26]). This could be expected, as nearly all orthodontic treatment is privately financed and privately provided. There are few studies from European countries in which access to orthodontic services has been examined, but these have also found inequalities in access according to socio-economic status (e.g. see references[27–29]). This could also be expected, as these studies were carried out in countries in which a fairly large part of the cost of treatment is paid by the patients.[30]

To our knowledge, there has been no research into the distributional effects of subsidized orthodontic treatment. The research question was examined using a large and unique set of population register data from Norway. In previous studies, survey data or dental claims data have been used (for a review see reference[22]). These studies have their limitations. They may suffer from different types of bias, such as sampling bias, non-response bias and recall bias.[31–33] Data for the complete study population, and reliable information from public sources for all key variables, was available. In that way, the results are less likely to suffer from the types of bias mentioned above.

2 | MATERIALS AND METHODS

2.1 | Data and variables

Reimbursement payments for orthodontic treatment are administered by the Norwegian Health Economics Administration.[34] All children and adolescents who receive subsidized orthodontic treatment are registered with this body. Most orthodontic treatment is carried out for children and adolescents aged 10–18 years.[19] For individuals within this age group, those who started treatment in 2019 were identified. In the reimbursement payments these patients were

registered with tariff code 601. They were given the value 1 on the dependent variable. Children and adolescents aged 10–18 years who were not registered with the Norwegian Health Economics Administration were given the value 0. Individuals who had completed orthodontic treatment during the period 2013–2019 were excluded from the study population.

All persons who live in Norway have a unique personal identification number. This made it possible to merge the data from the Norwegian Health Economics Administration with the following data registers in Statistics Norway:

1. Norwegian Registry for Personal Taxpayers: income for all people with a tax obligation in Norway[35]
2. Norwegian Standard Classification of Education: highest education of all persons living in Norway[36]
3. The Population Register on Immigration: country of origin of first and second generation immigrants to Norway[37]
4. Population and Housing Census: place of residence (municipality) of all persons living in Norway[38]

In the data from Statistics Norway, the parents of the children and adolescents in our study population could be identified. The income and level of education of the parents were used in the analyses. For place of residence and country of origin, data for individuals 10–18 years old were used.

2.2 | Analyses

The core regression model is defined with the following dependent variable: the probability of having started orthodontic treatment in 2019. The key independent variable was *net household income*, which consisted of labour income, capital income and all transfers from the government. Household income was adjusted to account for household composition using the OECD-modified equivalence scale.[39,40] The effect of income may vary according to the severity of the malocclusion. Therefore, separate regressions were run for individuals classified as being in very great need, great need or obvious need.[11,12] In each of the regressions, the individuals who had not started treatment were given the value 0. The regressions were estimated using a linear probability model. The model is described in detail in Data S1.

The following control variables were included in separate specifications: gender, age (fixed effects), parents' level of education, immigrant background and place of residence. Two dummy variables for education for each of the parents were included in the regressions. The highest educational level was university/college education. The middle educational level was upper secondary school. The lowest educational level was compulsory school education only (reference category). For immigrant background, western, non-western and Norwegian were distinguished between (reference category). In Norway, there were 18 counties in 2019. These were included as fixed effects to control for place of residence.

2.3 | Inequalities measured using concentration indices

Concentration indices were used to measure inequalities. These are commonly used to measure socioeconomic inequality in health and health care utilization.[41,42] These indices are in the range −1 to 1. The closer the indices are to 0, the smaller the inequalities. The way the concentration indices were calculated is given in Data S1. Results for both the unstandardized concentration index and the partial concentration index are presented.[41,42]

The unstandardized concentration index takes into account both the direct effect that household income has on the probability of having started treatment, and the indirect effects that are transmitted through the intervening variables.[43] In the model, the indirect effects would be the component of the association between the probability of having started treatment, and income that was due to the control variables.

In the literature, it is common to estimate the partial concentration index.[41,43] This is a measure of income-related inequality in health after removing the indirect effects of income that are transmitted through intervening variables. In our case, the partial concentration index would be a measure of the direct effect of income on the probability of having started treatment. The method of indirect standardization was used to estimate the partial concentration index.[43]

The unstandardized concentration index and the partial concentration index measure relative inequality. An alternative approach would be to measure absolute inequality, which quantifies the absolute differences between income groups according to the probability of having started orthodontic treatment. Wagstaff and Erregyers developed indices that measure absolute inequality.[44,45] These indices are particularly useful when the outcome is binary, as in our case. With binary outcomes, the minimum and maximum values of the concentration indices depend on the mean of the outcome variable.[44] This complicates comparison of the values of the concentration indices across populations in which the mean of the outcome variable varies. In our study, the proportion of individuals who were classified in severity group A was much lower than the proportion who were classified in groups B and C. Therefore, to take account of the fact that the mean of the outcome variable varied across the samples, inequalities were also measured using the corrected concentration index proposed by Erregyers[45] (for further details see Data S1).

2.4 | Supplementary analyses

An alternative way to describe inequalities in access to orthodontic treatment is to use margins plots. To do so, a multinomial logit model was estimated, in which the response variable had four groups: very great need, great need, obvious need or no need (the reference group). For model specification, see Data S1. Each individual was assigned to a decile, ranked from 1 to 10, based on net

equalized household income of the parents. Small or no differences in the coefficients between the deciles would indicate that access to orthodontic treatment is independent of income. In that case, the concentration indices would also be small.

Some children and adolescents who were assessed to have a need for orthodontic treatment did not receive it. These individuals may have parents with a low income who may not be able to afford orthodontic treatment even though it is subsidized. Patients who did not receive orthodontic treatment were classified into five groups according to parents' net household income. Whether there was an income gradient for those who received and those who did not receive orthodontic treatment, could then be examined. This analysis was carried out according to the severity of the malocclusion.

3 | RESULTS

3.1 | Descriptive statistics

In 2019, 7.6% of children and adolescents aged 10–18 years began orthodontic treatment. About 3.6% had great need for treatment, and 3.9% had obvious need. Very few had very great need (0.1%) (Table 1).

Key characteristics of the study population according to the severity of the malocclusion are shown in Table 2. With the exception of gender, most of the characteristics were evenly distributed according to severity. A higher proportion of boys than girls had very great need, while a lower proportion of boys than girls had obvious need. The mean net equalized household income was almost the same for all three groups of severity (the 95% confidence intervals overlapped). For those with no need for treatment, the mean net equalized household income was slightly lower than for those who had obvious need and great need (the 95% confidence intervals did not overlap).

3.2 | Concentration indices

For all three types of concentration index, the values were small (Table 3). This was the case irrespective of whether the unstandardized, the partial or the corrected index was used. These results indicate that the inequalities in access to orthodontic treatment were small.

The unstandardized indices were in the range 0.04 (Group A) to 0.05 (Group C). For all three groups of severity, the 95% confidence intervals overlapped. The values of the partial indices were significantly lower than the values of the unstandardized indices. The partial indices were in the range 0.008 (Group A) to 0.03 (Group C). The 95% confidence intervals for the partial indices did not overlap with the 95% confidence intervals of the unstandardized indices. For all three groups of severity, the measure of absolute inequality[45] was close to zero.

TABLE 1 The distribution of malocclusion according to the severity of the malocclusion. Population: 10–18 years of age ($n = 354\,439$).

Severity of the malocclusion	Group	Percent
Very great need	A	0.13
Great need	B	3.62
Obvious need	C	3.90
No need	D	92.35
Total		100

3.3 | Supplementary analyses

Margins plots from the estimation of the multinominal logit model are presented in Figure 1 (Data S1: Equation (4)). The graphs support the key findings reported in Table 3. For most of the income deciles, the lines are nearly horizontal. This was the case, independently of whether control variables were included in the regression.

For those with great need, the line was slightly steeper for the lowest decile, indicating inequalities in access for people in this income group. However, the difference in the probability of having started treatment between individuals in the lowest and the highest decile was small—less than 0.01 percentage points (Data S1). For most of the other deciles, the confidence intervals overlapped. In particular, this was the case in the models with control variables included (Data S1).

The proportion of individuals aged 10–18 years who did not receive orthodontic treatment according to parents' net household income is shown in Data S1. This proportion was fairly similar across income groups. All the 95% confidence intervals overlapped. This indicates that there is no income gradient for those who received and those who did not receive orthodontic treatment.

4 | DISCUSSION

In the present study, inequalities in access to orthodontic services for children and adolescents in Norway were examined using concentration indices. These indices are commonly used to examine inequalities in health care. One challenge when using concentration indices to study inequality is that their values may not have an intuitive interpretation.[41,46] For example, it is not clear which values reflect a large or a small inequality. This is because the index values are not expressed in natural units.

One way in which these indices can be given a meaningful interpretation is by multiplying them by 0.75.[46] In our case, this gives the percentage of those who started orthodontic treatment that would need to be redistributed from the richer half of the population to the poorer half of the population in order to eliminate inequality. The index value would then be zero.[41] In our study, the values of the Erregyers index (2009) were in the range 0.003 (group B) to 0.006

TABLE 2 Distribution of individuals according to the severity of the malocclusion.Population: 10–18 years of age ($n = 354\,439$). Proportions and mean values with 95% CI in brackets.

	Severity of the malocclusion			
Variables	**Very great need Group A**	**Great need Group B**	**Obvious need Group C**	**No need Group D**
Proportions				
Gender				
Boy	0.549 [0.502–0.594]	0.485 [0.476–0.494]	0.454 [0.446–0.463]	0.544 [0.543–0.546]
Mother's highest education				
Compulsary school education	0.155 [0.124–0.191]	0.154 [0.148–0.160]	0.149 [0.143–0.155]	0.164 [0.163–0.165]
Upper secondary education	0.308 [0.267–0.352]	0.291 [0.283–0.299]	0.287 [0.279–0.294]	0.299 [0.298–0.301]
University/college education	0.515 [0.469–0.561]	0.528 [0.519–0.537]	0.538 [0.529–0.546]	0.502 [0.501–0.504]
Father's highest education				
Compulsary school education	0.162 [0.130–0.198]	0.156 [0.150–0.163]	0.151 [0.146–0.157]	0.169 [0.168–0.170]
Upper secondary education	0.436 [0.391–0.482]	0.425 [0.417–0.434]	0.412 [0.404–0.421]	0.417 [0.413–0.419]
University/college education	0.374 [0.330–0.420]	0.366 [0.357–0.374]	0.380 [0.372–0.388]	0.353 [0.351–0.355]
Ethnic background				
Norwegian	0.662 [0.616–0.704]	0.654 [0.646–0.662]	0.629 [0.621–0.637]	0.644 [0.643–0.646]
Western	0.139 [0.110–0.175]	0.161 [0.155–0.168]	0.153 [0.147–0.159]	0.161 [0.160–0.162]
Non-western	0.199 [0.165–0.239]	0.184 [0.178–0.191]	0.219 [0.212–0.226]	0.195 [0.194–0.196]
Mean values				
Age	14.13 [13.99–14.37]	12.57 [12.54–12.60]	12.89 [12.86–12.92]	13.48 [13.47–13.49]
Net household income (Euro) (equivalence scale adjusted)	42 808 [40732–44 885]	43 816 [43268–44 364]	44 748 [43661–45 836]	42 305 [42107–42 502]
Total	452	12 823	13 812	327 352

TABLE 3 Different types of concentration indices according to the severity of the malocclusion. 95% CI in brackets.

	Severity of the malocclusion		
Type of concentration index	**Very great need Group A**	**Great need Group B**	**Obvious need Group C**
Unstandardized	0.036 [−0.017–0.089]	0.040 [0.031–0.050]	0.051 [0.041–0.060]
Partial (standardized)	0.0079 [0.0075–0.0084]	0.023 [0.020–0.025]	0.035 [0.032–0.037]
Corrected (Erreygers)	0.00004 [−0.00040–0.00048]	0.003 [0.001–0.006]	0.006 [0.003–0.008]

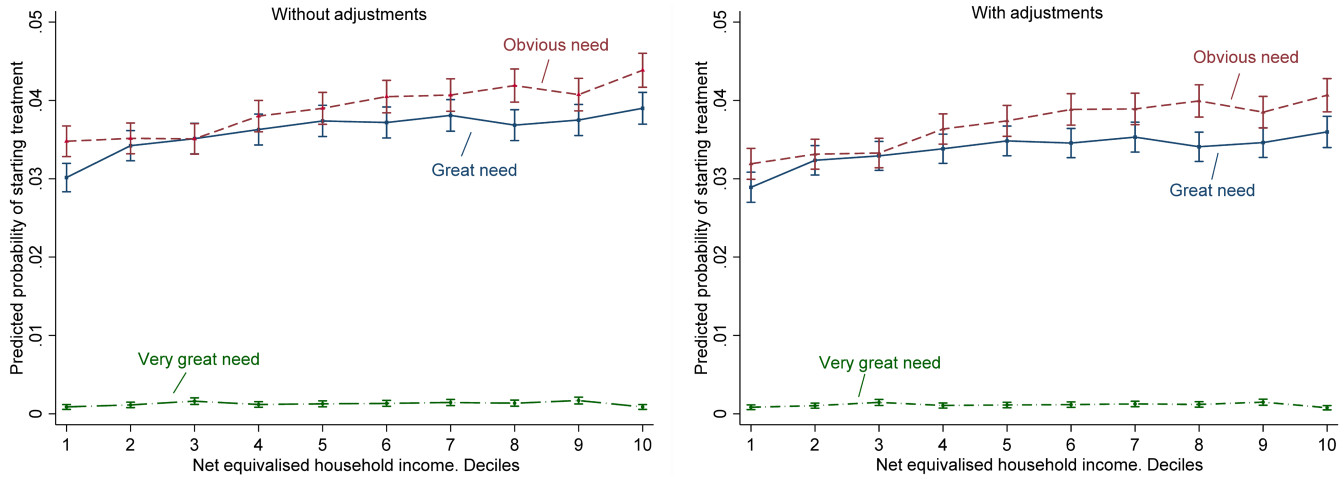

FIGURE 1 The probability of starting orthodontic treatment according to the severity of the malocclusion and net equivalized household income. Marginal probabilities. 95% CI.

(group C). Following Koolman and van Doorslaer,[46] less than 1% of individuals would then have to be redistributed. This is a small percentage, which indicates that inequalities in access to orthodontic treatment are not a serious problem. This is further supported by the horizontal lines shown in the margins plots in Figure 1.

To our knowledge, this is the first study in which the distributional effects of subsidized orthodontic treatment have been examined. The results show that it is possible to achieve the egalitarian aim of equality in service provision by subsidizing orthodontic treatment. Our findings are encouraging, and other countries could learn from this, particularly countries in which orthodontic treatment is privately financed and privately provided. Inequalities in access have been found in these countries (for a review see reference[22]). The Norwegian system of organizing and financing orthodontic treatment is designed to reduce inequalities, so that patients with the greatest need for orthodontic treatment receive the largest reimbursement. In that way, parents with low income, who have children classified with very great need (group A) or great need (group B), are able to afford orthodontic treatment for their children. Further, the level of reimbursement is so high that there is no income gradient for those who received and those who did not receive orthodontic treatment.

If other countries introduce a similar need-based system for financing orthodontic treatment, at least two other factors have to be taken into account. First, there must be a sufficient number of orthodontists to meet the need for treatment in the population. If there are too few orthodontists, then waiting time for treatment may be long, the services may need to be rationed and some patients may not be offered treatment.[20] A commonly used measure of availability of orthodontic treatment is the number of 12-year-olds per orthodontist person-year. In Norway, the mean number of 12-year-olds per orthodontist person-year is 348.[21] This is a high ratio, and one of the highest among the European countries.[47] One implication of this high ratio, is that orthodontists are evenly distributed across the country.[20] Thus, orthodontic services are easily available throughout the country. This has made it possible to achieve the egalitarian aim of equality in access to orthodontic treatment independent of parents' income and location. This would not have been possible if there were too few orthodontists.

Second, it has to be economically attractive for orthodontists to treat children and adolescents rather than adults. Few adults have orthodontic treatment in Norway. This may indicate that the level of reimbursements that orthodontists receive from the National Insurance Administration is high enough so that they are motivated to give priority to treating children and adolescents rather than adults.

5 | CONCLUSIONS

In conclusion, inequalities in access to orthodontic services for children and adolescents aged 10–18 years in Norway have been examined. The research question was examined using a large and unique set of population register data from Norway. Inequalities were measured using different types of concentration index. The values of the indices were small, indicating that access to orthodontic treatment is independent of parents' income. In Norway, policy makers have pursued an equitable distribution of dental services for children and adolescents up to the age of 18. The objective of this policy is that dental services should be allocated according to children's need, and not according to parents' ability to pay. With respect to access to orthodontic services, policy makers have achieved their ambition of an equitable distribution to a large degree.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data for this project are owned by the Norwegian Directorate of Health and Statistics Norway. The authors are willing to give advice to researchers regarding procedures to apply for access to these data.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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