The Geodemographic Distribution of Caries Experience in Neighboring Fluoridated and Nonfluoridated Populations

Martin Tickle, PhD; Keith M. Milsom, MSc; Tony M. Jenner, MSc; Anthony S. Blinkhorn, PhD

Abstract

Objective: *This study compares the geodemographic distribution of caries experience in neighboring fluoridated and nonfluoridated populations.* ***Methods:*** *All 5-year-old children living in fluoridated (N=1,422) and nonfluoridated (N=4,779) areas of Cheshire, UK, were examined by trained and calibrated examiners. The Target Market level of the Super Profiles geodemographic classification was used to produce market penetration ranking reports for caries experience. The same area types were compared in fluoridated and nonfluoridated populations. Lorenz curves and Gini coefficients were generated from the outputs of the penetration rankings.* ***Results:*** *There was a 12.4 percent difference in prevalence and a 29.4 percent difference in dmft between fluoridated (dmft>0=32.4%, dmft=1.01) and nonfluoridated (dmft>0=37.0%, dmft=1.43) areas. The area types at the top of both penetration rankings were deprived in nature and those at the bottom were affluent. The Gini coefficients in each area were 22.7 and 23.7 percent.* ***Conclusions:*** *The results demonstrate that water fluoridation is effective at preventing dental disease after controlling for confounding factors. In both populations the majority of disease was not confined to a small number of deprived area types. This undermines the contention that a targeted approach to caries prevention is a practical option. [J Public Health Dent 2003; 63(2):92-98]*

Key Words: water fluoridation, deprivation, geodemographic classifications, dental caries.

It is widely accepted that a large proportion of the dental caries experience of a population can be found in a small percentage of the population (1,2). The close association between socioeconomic status and dental caries is also well known (3,4); consequently, the majority of population disease is believed to be located in communities living in deprived areas. At face value this concentration of the disease should help public health dentists target prevention programs toward this disadvantaged minority, which experiences the bulk of caries. This targeted approach should mean health resources are used more efficiently than would be the case if a prevention program were applied to the whole population.

Targeted public health prevention programs rely on two methodologies: a geographical approach or a settings approach. Geographical targeting relies on tools that can categorize areas or localities, usually local government or health service administrative areas, based on the demographic, socioeconomic, and geographical nature of each area. Business commonly uses these techniques to target sales of products or services to specific populations (5). The marketing industry developed geodemographic classifications of areas specifically to aid their business endeavors and they have proved to be powerful discriminators of consumer behavior (6). These techniques may have potential uses in the health context as tools for targeting preventive or health promotion interventions.

The settings approach utilizes sites or venues where groups at greater risk of developing disease congregate, as a focus to deliver health promotion initiatives to these groups. Commonly used settings include schools, the workplace, community health clinics, and communal residential institutions.

There has been a wide acceptance in many parts of the dental public health community (1) that 80 percent of the disease resides in 20 percent of the population, the so-called 80:20 phenomenon. Recent interlinked studies of dental caries prevalence and experience patterns in 5-year-old children (7,8) have demonstrated that while the disease is not concentrated to this extent, nevertheless approximately 50 percent of disease was found in 20 percent of the population (7). These studies also looked at the geographical distribution of both caries experience (7) and prevalence (8), and although large inequalities were found between populations living in deprived and affluent areas, there was a gradual change between these extremes. Therefore, the majority of disease was not confined to a small number of deprived areas. A similar picture was observed when the school that the children attended was used as a categorical variable to segment the population (8). These findings cast doubt on the effectiveness of targeting high-risk groups, using either a geographical methodology or a settings approach, to reduce whole population disease levels.

However, these studies (7,8) were undertaken on the same high caries (dmft=2.56, dmft>0=55.3 percent) population and the authors questioned whether or not caries experience would be more concentrated in a population with lower levels of caries. If this were the case, a targeted approach to caries prevention might be

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more appropriate for populations with low caries prevalence. This question is especially intriguing for a low prevalence population to which a whole population strategy has already been applied, such as a community receiving fluoridated water.

The aim of this study was to compare the geodemographic distribution of caries experience in neighboring fluoridated and nonfluoridated populations of 5-year-old children. Comparing the geodemographic distribution would help determine if the majority of caries is confined to a small number of deprived areas as the population caries experience declines.

Methods

A whole population survey of 5-year-old children was commissioned in 1997–98 in the county of Cheshire in the northwest of England. The study area included the southern part of the county where the water supply for about 50,000 residents has been artificially fluoridated since the early 1970s.

Each child attending a state-maintained primary school in the county was examined for dental caries by trained and calibrated examiners (9,10) working to a common protocol. In the United Kingdom local National Health Service surveys are coordinated by the British Association for the Study of Community Dentistry (BASCD) and performed by experienced, trained, and calibrated examiners. The BASCD guidelines for calibration of examiners suggest that three tests should be applied to identify whether or not an individual examiner has calibrated:

- Individual examiner means should lie within the 95 percent confidence intervals of the overall group mean.
- Sensitivity of 80 percent (75% sensitivity is used for the primary dentition) and specificity of at least 90 percent should be achieved when individual DMFT scores are compared with the benchmark (a regional epidemiologist who is calibrated nationally).
- Cohen's kappa statistic also is employed to make inter- and intraexaminer comparisons. An agreement level of 0.75 should be achieved.

Each subject's home postcode was recorded. This is an alphanumeric code used to identify groups of about 15 neighboring, residential addresses in the United Kingdom. The postcode was developed by the Royal Mail as an aid to the computerized sorting of mail. By referring to each subject's postcode the relevant Enumeration District (ED) of each subject could be identified. The ED is the smallest geographical unit of the UK Census and represents on average 120 households, containing about 400 individuals.

The relevant Super Profile Target Market codes for each ED also were attached to each record. The Super Profiles geodemographic classification (11) classifies every ED in the United Kingdom according to data primarily from the UK Census. The UK Census is held every 10 years. Completion of Census forms is mandatory. This policy results in high coverage; for example, coverage of the 1991 Census was 97.8 percent (12). Consequently, UK Census data have spatial integrity at a small area level.

The Super Profiles classification has three hierarchical tiers. In this study the 41-group Target Markets level of the classification was used. (Target Market 41 relates to unclassified areas.) Like most geodemographic classifications, a "pen picture" describes the characteristics of each Target Market. These are brief stereotypical descriptions summarizing the key features of the type of area each Target Market represents. These descriptions provide an idea of the age of the population for each type of area, the ethnic mix, the socioeconomic profile of the area, and an indication of the local geography—for example, whether it is urban or rural. The terms used relate to, and are restricted by, the information collected in the Census and are therefore specific to the social and cultural situation in the United Kingdom.

The core of the Super Profiles classification is based exclusively on UK Census data. The classification is capable of being augmented and updated with noncensus data from the electoral role, commercial trading data, and descriptor variables—most notably from the Target Group Index (TGI). The TGI is the outcome of a regular survey of product consumption and media preferences of approximately 24,000 respondents. At Target Market-level, two ordinal scale rankings were produced. One used TGI data to provide a measure of mean income for each Target Market, and the other was based on the first variable of the principal component analysis used to create the classification, in this case car ownership. The ranking produced by the TGI was used in the final classification because this is a national classification of area types and patterns of car ownership (and their relationship to income) in central London are quite distinct from those elsewhere in the country.

In the northwest of England the water supply is provided through a network divided into geographical areas known as compliance zones. The water company provided an electronic look-up table that matched postcodes to water compliance zones. This enabled the population living in households receiving a fluoridated water supply to be identified and separated from the nonfluoridated population.

Penetration ranking reports for both fluoridated and nonfluoridated populations were produced by a spreadsheet analysis in Microsoft Excel. The Target Market-level of the Super Profiles geodemographic classification was used in these analyses to categorize the two populations according to caries experience. The nonfluoridated area covered a wider geographical area and had a larger population; therefore, a greater number of Target Markets were represented in this population. To ensure that like was compared with like, any Target Markets not represented in the fluoridated population were excluded from the analysis of the nonfluoridated population.

A penetration ranking report is a tabular output produced by the Excel spreadsheet analyses. To undertake the analyses, the total population of 5-year-old children living in each of the Super Profiles Target Markets was calculated. Then a dmft score for the 5-year-olds living in each Target Market was produced. These dmft values were multiplied by the denominator population in each Target Market, then divided by the number of the total population. The contents of this column were used to rank the whole table. Cumulative percent of population dmft and cumulative percent of the total population were then calculated. The ranking "penetration" at Target Market level was expressed by the cumulative percentage of the population disease experience. The outputs of the penetration analyses were used to plot Lorenz curves, from

which Gini coefficients were calculated. The Gini coefficient provides a summary index of the Lorenz curve by expressing the area between the curve and diagonal as a percentage of the total area above the diagonal. The higher the Gini, the greater the area between the two lines, and the more unequal the distribution of the variable under study.

Results

The total number of 5-year-olds examined in the fluoridated area was 1,422 and 4,779 children were examined in the nonfluoridated area. Only 33 of the possible 41 Target Markets were represented in the fluoridated area, whereas 38 Target Markets were present in the nonfluoridated area. The population of 5-year-olds living in these five Target Markets (N=130; 0.03% of the nonfluoridated population) were excluded from the analyses. All of the Target Markets in the fluoridated area were present in the nonfluoridated area. Caries prevalence of the fluoridated population was 32.4 percent compared with 37.0 percent in the nonfluoridated population, a difference of 12.4 percent. There was a 29.4 percent difference in caries severity (fluoridated population dmft=1.01, SD=1.98 vs dmft=1.43, SD=2.54 nonfluoridated population).

Table 1 shows the penetration analysis for the nonfluoridated population, dmft ranged from 2.82 (Target Market 39) to 0.22 (Target Market 30). The penetration ranking showed that 33.4 percent of the population dmft was found in 26.5 percent of the population living in the four topmost-ranked area types. The Lorenz curve and Gini coefficient (Figure 1), derived from plotting cumulative percent of the population against cumulative percent of dmft, demonstrated that the Target Markets had an effectiveness (in terms of confining the majority of disease experience to a small number of types of area) of 22.7 percent.

Table 2 presents the results of the penetration analysis for the fluoridated population. Very similar results were found, although due to small numbers in some of the Target Markets in the fluoridated area, the dmft values ranged from 4.00 (Target Market 20; N=2) to 0.00 (Target Market 41; N=4). The geodemographical distribution of the disease across the population was very similar to that of the

FIGURE 1
Lorenz Curve with Gini Coefficient for the Nonfluoridated Area of Cheshire: Cumulative Percent of Population dmft Plotted Against Cumulative Percentage of Total Population Categorized by Super Profiles Target Markets

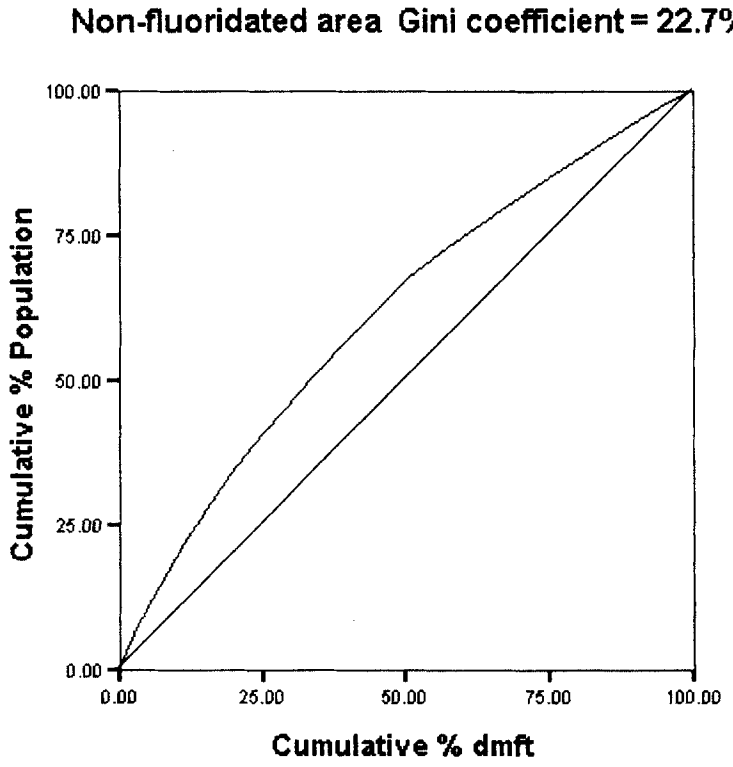


FIGURE 2
Lorenz Curve with Gini Coefficient for the Fluoridated Area of Cheshire: Cumulative Percent of Population dmft Plotted Against Cumulative Percentage of Total Population Categorized by Super Profiles Target Markets

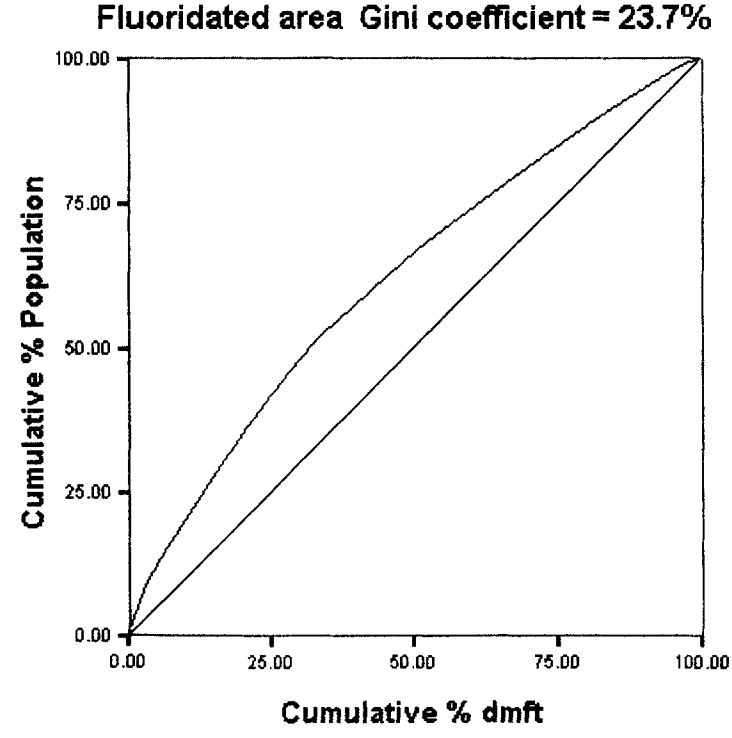


TABLE 1
Penetration Ranking Report: Population of 5-year-old Children Living in Nonfluoridated Part of Cheshire Segmented by Super Profile Target Markets According to Caries Experience

Target Market (Affluence Ranking)	*N*	dmft	dmft * *n*/ Total	% of Total dmft	% of Total Population	Cumulative % Total dmft	Cumulative % Total Population
33	339	2.22	0.161	11.25	7.27	11.25	7.27
11	443	1.28	0.122	8.50	9.49	19.75	16.76
38	250	1.91	0.102	7.15	5.36	26.90	22.12
27	206	2.10	0.093	6.48	4.41	33.38	26.53
24	287	1.44	0.088	6.16	6.15	39.54	32.68
34	171	2.35	0.086	6.00	3.66	45.54	36.35
39	131	2.82	0.079	5.54	2.81	51.08	39.16
15	266	1.36	0.078	5.43	5.70	56.51	44.86
37	151	2.11	0.068	4.77	3.24	61.28	48.09
36	148	2.03	0.064	4.49	3.17	65.77	51.26
4	304	0.94	0.061	4.26	6.52	70.03	57.78
28	114	2.18	0.053	3.73	2.44	73.76	60.22
6	262	0.83	0.047	3.25	5.62	77.00	65.84
2	247	0.81	0.043	2.99	5.29	80.00	71.13
8	139	1.17	0.035	2.42	2.98	82.42	74.11
7	155	0.79	0.026	1.84	3.32	84.26	77.43
16	103	1.18	0.026	1.83	2.21	86.09	79.64
22	84	1.33	0.024	1.68	1.80	87.76	81.44
19	103	1.03	0.023	1.59	2.21	89.35	83.65
1	155	0.64	0.021	1.48	3.32	90.83	86.97
14	93	1.01	0.020	1.41	1.99	92.24	88.96
13	64	1.34	0.018	1.29	1.37	93.52	90.33
26	75	1.04	0.017	1.17	1.61	94.69	91.94
17	47	1.40	0.014	0.99	1.01	95.68	92.95
18	97	0.67	0.014	0.97	2.08	96.65	95.03
12	95	0.59	0.012	0.84	2.04	97.49	97.06
20	37	1.24	0.010	0.69	0.79	98.17	97.86
23	27	1.48	0.009	0.60	0.58	98.77	98.44
32	24	1.54	0.008	0.55	0.51	99.33	98.95
25	20	1.05	0.005	0.31	0.43	99.64	99.38
40	14	1.21	0.004	0.25	0.30	99.90	99.68
41	6	0.83	0.001	0.07	0.13	99.97	99.81
30	9	0.22	0.000	0.03	0.19	100.00	100.00
Total	4,666	1.43		100	100		

*Target Market areas not present in the fluoridated area of Cheshire excluded from analysis.

nonfluoridated area, with 35.0 percent of the population dmft contained within the 28.0 percent of the total population living in the four Target Markets at the top of the ranking. This similarity in the geodemographical distribution of disease was also demonstrated by the resultant Lorenz curve (Figure 2), which produced a Gini coefficient of 23.7 percent.

There was a gradual fall from the top (Target Markets largely deprived in nature) to the bottom (largely affluent Target Markets) of each ranking; consequently, there was no obvious cut-off point between areas with high and low caries experience. The same seven Target Markets (24, 33, 27, 15, 39, 34, 38) appeared in the top 10 of each penetration ranking (Tables 1 and 2). These areas generally were characterized by having a high proportion of young families; high unemployment (representative of insecurity and lack of material resources); low rates of home ownership (a proxy indicator of wealth); and a higher proportion of smaller, low-status housing occupied by blue collar families. Some area types (Target Markets 38, 39) were characterized by high unemployment and many single-parent families.

The ranking in each analysis (Tables 1 and 2) was not linear according to the affluence ranking of the Target Markets. Therefore, deprived areas low down on the affluence ranking that had high caries levels—for example, Target Markets 34 (dmft=2.35) and 38

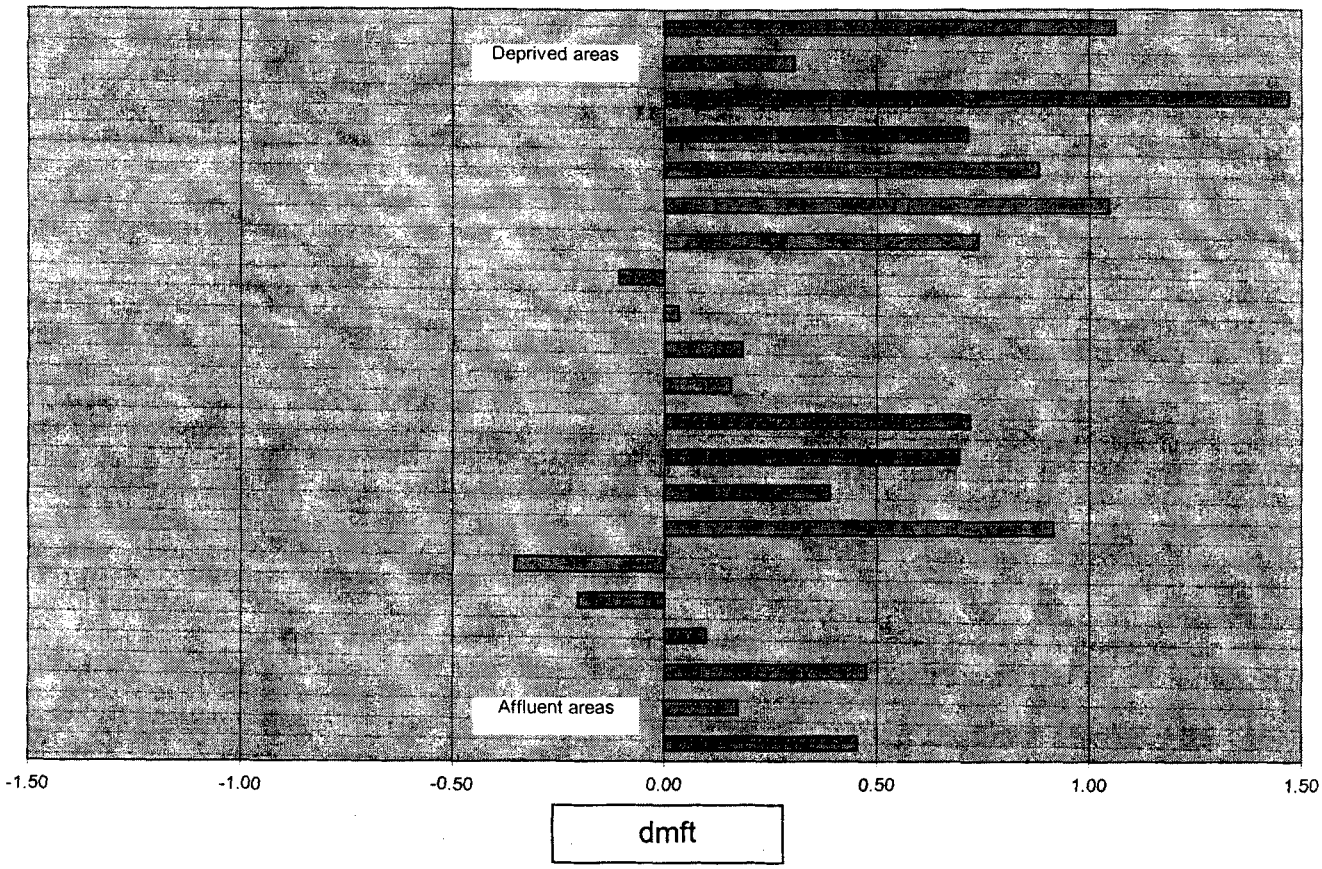
TABLE 2
Penetration Ranking Report: Population of 5-year-old Children Living in Fluoridated Part of Cheshire Segmented by Super Profile Target Markets According to Caries Experience

Target Market (Affluence Ranking)	*N*	dmft	dmft * *n*/ Total	% of Total dmft	% of Total Population	Cumulative % Total dmft	Cumulative % Total Population
24	107	1.40	0.105	10.43	7.52	10.43	7.52
33	122	1.17	0.101	9.94	8.58	20.38	16.10
26	95	1.15	0.077	7.58	6.68	27.96	22.78
27	74	1.36	0.071	7.02	5.20	34.98	27.99
15	149	0.67	0.070	6.95	10.48	41.93	38.47
39	55	1.76	0.068	6.75	3.87	48.68	42.33
34	56	1.46	0.058	5.70	3.94	54.38	46.27
4	106	0.76	0.057	5.63	7.45	60.01	53.73
38	48	1.60	0.054	5.35	3.38	65.37	57.10
19	85	0.85	0.051	5.01	5.98	70.38	63.08
11	37	1.49	0.039	3.82	2.60	74.20	65.68
36	35	1.31	0.032	3.20	2.46	77.40	68.14
7	59	0.69	0.029	2.85	4.15	80.25	72.29
12	37	0.95	0.025	2.43	2.60	82.68	74.89
28	17	1.59	0.019	1.88	1.20	84.56	76.09
37	42	0.64	0.019	1.88	2.95	86.44	79.04
17	35	0.69	0.017	1.67	2.46	88.11	81.50
18	43	0.51	0.015	1.53	3.02	89.64	84.53
32	14	1.36	0.013	1.32	0.98	90.96	85.51
40	6	3.17	0.013	1.32	0.42	92.28	85.94
14	29	0.62	0.013	1.25	2.04	93.53	87.97
6	48	0.35	0.012	1.18	3.38	94.71	91.35
8	11	1.09	0.008	0.83	0.77	95.55	92.12
22	17	0.59	0.007	0.70	1.20	96.24	93.32
2	28	0.36	0.007	0.70	1.97	96.94	95.29
1	11	0.82	0.006	0.63	0.77	97.57	96.06
13	21	0.43	0.006	0.63	1.48	98.19	97.54
30	4	2.25	0.006	0.63	0.28	98.82	97.82
20	2	4.00	0.006	0.56	0.14	99.37	97.96
25	14	0.50	0.005	0.49	0.98	99.86	98.95
16	7	0.14	0.001	0.07	0.49	99.93	99.44
23	4	0.25	0.001	0.07	0.28	100.00	99.72
41	4	0.00	0.000	0.00	0.28	100.00	100.00
Total	1,422	1.01		100	100		

(dmft=2.82) in Table 1, and Target Markets 39 (dmft=1.76) and 34 (dmft=1.46) in Table 2—did not appear at the very top of the ranking. This was especially so in the penetration ranking for the fluoridated area (Table 2) in which some of the area types were not well represented, and many of the Target Markets at the bottom of the ranking had very small numbers. However, for those areas with $N>30$ with a low dmft—for example, Target Markets 1 (dmft=0.64) and 12 (dmft=0.59) in Table 1, and Target Markets 6 (dmft=0.35) and 14 (dmft=0.62) in Table 2—are area types that are demographically more mature, more affluent in character with large residential properties in evidence and high rates of home ownership.

Figure 3 represents the differences in caries experience in the same area types in fluoridated and nonfluoridated areas. Target Markets with $N<30$ were excluded from this analyses. In three Target Markets (11, 12, 26) dmft was greater in the fluoridated area than the nonfluoridated area, and in the remaining 18 Target Markets the dmft was lower. A bivariate linear regression analysis with differences in dmft as the dependent variable and the Target Market affluence ranking as the dependent variable demonstrated a significant linear relationship ($\beta=0.02$; SE of $\beta=0.01$; $P<.05$); the differences in dmft were greater in disadvantaged areas.

FIGURE 3
Differences in dmft of Super Profile Target Market Area Types in Fluoridated and Nonfluoridated Areas in Cheshire (Target Markets with $N<30$ were excluded from analyses)



Discussion

The county of Cheshire—irrespective of fluoridated or nonfluoridated areas—is predominantly rural in nature, with small towns and villages, and is for the most part fairly affluent. It does not have the significant areas of deprivation associated with the neighboring cities of Liverpool and Manchester. It also has a very ethnically homogeneous population; the majority of residents are white British.

The ranking produced in the market penetration tables is a function of both the denominator populations in each Target Market and also the dmft. The Target Markets with the highest dmft scores did not necessarily appear at the very top of the ranking. Similarly, the topmost ranked Target Markets are not necessarily the most deprived. They are more likely to be deprived, but as the final ranking in the tables is a function of both the denominator population and the caries experience, they are not necessarily the most deprived according to the TGI ranking. This accounts for the nonlinearity in the TGI affluence ranking of the Target Markets in Tables 1 and 2. The failure to see a concentration of caries in a small number of areas could be due to the classification used in this study. This is unlikely, as an earlier study by Tickle et al. (8) compared the performance of commonly used composite area measures of multiple deprivation, single Census variables, other geodemographic classifications, and the school that the children attended with Super Profiles and found that all of these classifications were very similar in their ability to segment a population according to caries prevalence.

The results from the low prevalence (37.0 percent), nonfluoridated population can be contrasted with the results of the earlier study in the higher prevalence (55.3 percent) population (7). Although both studies took place in the northwest of England, the structure of the population under study in Cheshire differed from that of the earlier study. The population in Cheshire had a smaller proportion of the population living in Target Markets that were deprived in character and those with an ethnic dimension were less evident. In both high- and low-prevalence populations there was a very gradual fall in the cumulative percent of the total dmft between the top and bottom of the market penetration ranking. There was a marginal increase in the ability of Super Profiles Target Markets to partition the low-prevalence population according to caries experience. This fact was demonstrated by the Gini coefficients: 22.7 percent in this study compared to 16.2 percent in the high-prevalence population. This would seem to suggest that as population disease prevalence and severity decrease, the disease does tend to concentrate in the more deprived areas, but not to a substantial degree.

This concentration of disease in the population as prevalence and disease severity fall is not sufficient to make a targeted approach to disease prevention effective, if reduction of total disease experience is the aim. For example, if the worst third of the population were to be targeted with a preventive intervention (32.7% of the cumulative percent of the population) (Table 1), approximately 60 percent of the popu-

lation disease (100–39.5) would be unaffected. Therefore, although deprived Target Markets are likely to experience higher levels of disease, there will always be numbers of children living in more affluent areas who develop caries and collectively retain a sizable proportion of the population share of disease.

This gradual fall also creates problems if the aim of a targeted approach is to reduce inequalities. The steady fall in the percentage of population dmft from the top to bottom of the ranking means there is no clear cut-off point, or natural break indicating where to draw a line separating "deprived and in need" from "affluent." Therefore, any decision as to which areas get the intervention and which do not is arbitrary and subjective, and susceptible to challenge.

When the fluoridated and nonfluoridated populations in Cheshire are compared, there was a 12.4 percent difference in caries prevalence and a 29.4 percent difference in caries severity. This comparison compares like with like, as the Super Profiles typology is a national classification and therefore the same categories of areas were compared, thus removing the confounding influences of social, economic, geographic, ethnic, and demographic factors. The distribution of the difference in dmft scores in each area (Figure 3) showed larger differences in the more deprived areas than the affluent areas, suggesting that water fluoridation has a larger effect in high-disease, more deprived areas than in low-disease, more affluent areas. These findings are supported by recent research showing that adding fluoride to the water supply can reduce inequalities in caries (13,14).

Although prevalence and severity were lower in the fluoridated population, the geographical distribution of disease was similar to the nonfluoridated population, as the Gini coefficients were almost identical (22.7% vs 23.7%). Therefore, in this instance fluoride does not further concentrate the residual disease. This can be explained by the fact that water fluoridation is a whole population intervention and its effects will be felt across all groups in the population. If it preferentially benefits high-disease, deprived areas, this will lessen any tendency for the majority of residual population dmft to be found in a small number of deprived areas.

The geographical distribution of disease in the fluoridated population also demonstrates that a targeted approach would not be an effective way of preventing any residual disease following fluoridation of the water supply. Paradoxically, a second whole population approach would be required to reduce the remaining levels of disease. Water fluoridation is specific to dental caries prevention, and although its effectiveness in reducing the levels of caries has been demonstrated (15), it cannot completely eradicate dental caries, nor can it address the etiologic broad determinants of tooth decay. The underlying socioeconomic and behavioral influences responsible for dental caries are common risk factors for many other diseases (16). Therefore, broader public health strategies complementary to fluoride programs are also needed to resolve these fundamental reasons for ill health.

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References

1. Murray JJ, Pitts NB. Trends in oral health. In: Pine CM, ed. Community oral health. Oxford, UK: Wright, 1997:126-45.
2. Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle JA, Winn DM, Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991. J Dent Res 1996;75:631-41.
3. Gift HC, Drury TF, Nowjack-Raymer RE, Selwitz RH. The state of the nation's oral health: mid-decade assessment of Healthy People 2000. J Public Health Dent 1996;56:84-91.
4. Pitts NB. Inequalities in children's caries experience: the nature and size of the UK problem. Community Dent Health 1998; 15:296-300.
5. Birkin M. Customer targeting, geodemographics and lifestyle approaches. In: Longley P, Clarke G, eds. GIS for business and service planning. Cambridge, UK: GeoInformation International, 1995:104-49.
6. Brown PJB. Exploring geodemographics. In: Masser I, Blakemore M, eds. Handing geographical information: methodology and potential applications. London: Longman, 1991: 221-58.
7. Tickle M. The 80:20 phenomenon: help or hindrance to planning caries prevention programmes? Community Dent Health 2002;19:39-42.
8. Tickle M, Brown PJB, Blinkhorn AS, Jenner AM. Comparing the ability of different area measures of socio-economic status to segment a population according to caries prevalence. Community Dent Health 2000;17:138-44.
9. Mitropoulos CM, Pitts NB, Deery C. British Association for the Study of Community Dentistry criteria for the standardised clinical assessment of dental health (1992/3) In: BASCD trainer's pack for caries prevalence studies 1992/3. Dundee, UK: University of Dundee, 1992.
10. Pine CM, Pitts NB, Nugent ZJ. British Association for the Study of Community Dentistry (BASCD) guidance on the statistical aspects of training and calibration of examiners for surveys of child dental health. A BASCD coordinated dental epidemiology programme quality standard. Community Dent Health 1997;14 (Suppl 1):18-29.
11. Batey PWJ, Brown PJB. From human ecology to customer targeting: the evolution of geodemographics. In: Longley P, Clarke G, eds. GIS for business and service planning. Cambridge, UK: GeoInformation International, 1995:77-103.
12. Heady P, Smith S, Avery V. 1991 census validation survey: coverage report. London, UK: OPCS Her Majesty's Stationery Office, 1994.
13. Jones CM, Taylor GO, Whittle JG, Evans D, Trotter DP. Water fluoridation, tooth decay in 5-year-olds, and social deprivation measured by the Jarman score: analysis of data from British dental surveys. Br Med J 1997;315(7107):514-17.
14. Riley JC, Lennon MA, Ellwood RP. The effect of water fluoridation and social inequalities on dental caries in 5-year-old children. Int J Epidemiol 1999;28:300-5.
15. McDonagh MS, Whiting PF, Wilson PM et al. Systematic review of water fluoridation. Br Med J 2000;321(7265):855-9.
16. Sheiham A. The role of the dental team in promoting dental health and general health through oral health. Int Dent J 1992;42:223-8.