Congruence between self-reported and actually provided prosthodontic services among Swedish dentists

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The purpose of this study, comprising two parts, was to investigate the congruence between answers given by general dentists in questionnaires concerning prosthodontic services and the recorded information on the services actually performed by each dentist. In Part I it is investigated whether questionnaire reports of weekly working hours devoted to prosthodontics can be used as indicators of actual prosthodontic production. Part II deals with the dentists' self-reported numbers of single crowns, fixed partial dentures (FPDs), and removable dentures. These reported services are compared with the services actually provided. Part I: A regression analysis indicates a lacking precision for the individual dentist, indicated by a relatively low explained variance ($R^2 = 0.20$). However, a highly significant association is seen between the two production measures ($P = 0.000$). Part II: The congruence between stated and actually provided services is higher for single crowns and removable dentures than for FPDs. Bivariate regression models are statistically significant for all three services. In Part II, the reported weekly working hours used for prosthodontics covaries significantly with prosthodontic production, but the association is not as strong as in Part I. Although the precision in both Part I and Part II is low for the individual dentist, the questionnaire measure is found to be useful as an indicator in a population of dentists. It is concluded that the questionnaire data can be used as reasonably valid expressions of prosthodontic activity in population-oriented analyses among general dentists. ☐ *Clinical decision-making; delivery of dental care; prosthodontics; regression models*

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Questionnaire methods are frequently used in studies of dental care, as well as in studies of clinical decision-making among dentists. A common finding has been a great variation among dentists in decisions, choice of treatment, and preferences (1–6). The reasons for the variations, however, are not clear. In a report in 1990 it was stated: 'The extent to which variation in dentists' detection of caries, evaluation of existing restorations, and identification of damaged teeth are associated with characteristics of the dentist, the practice, and the patient is completely unknown' (4).

One reason for the reported variability is that it is possibly artefactual and really due to lacking validity of the questionnaire data. In this context, studies of the congruence between different measures of for example treatment frequencies can be a step in judging the measurement validity. The validity of responses to questionnaires has been evaluated in several studies, but not in populations of dentists (7–12). To our knowledge, no previous study has focused on the congruence between self-reported and actually provided prosthodontic services among dentists.

In Sweden there are two systems for the delivery of dental care. About half of the dentists are private practitioners (PP), the other half employed in the Public Dental Health Service (PDHS). Both categories of dentists are affiliated to the same general dental insurance (which is mandatory and all-encompassing, with the participation of practically all Swedish dentists). The insurance system offers the possibility to assess the amount of service provided by the dentists. From the local insurance offices (for PP) and from the county councils (for PDHS), data regarding the prosthodontic services performed by each dentist can be made available for scientific purposes. Therefore, the services reported by the participants in a questionnaire study could be compared to those actually provided, and for a specified period of time.

In a research project on prosthodontic decision-making, assessment of measurement of prosthodontic production was an important component. There were two parts: Part I, a pilot study, was carried out to test the questionnaire instrument (13). Questionnaires were sent to all PPs in one county and to all PDHS dentists in another. Questions concerning the amount of time used for prosthodontic care were included. Part II, the pilot, was developed into a main study based on a nationally representative random sample of Swedish general dentists.

The aim of the present study was to investigate the

congruence between the questionnaire responses regarding prosthodontic services and the services actually provided. This was done to find evidence for the validity of questionnaire self-reports. More specifically, two questions have to be answered: 1. Can questionnaire reports of the working hours spent on prosthodontics be used as indicators of actual prosthodontic production? (This question can be answered by the material of both parts of the study.) 2. Do stated service frequencies of different prosthodontic treatments correspond with the services actually delivered? (This question can be answered by the material from the second part of the study.)

Materials and methods

The investigation comprised two parts based on responses to two questionnaire studies. The study design and performance have been presented previously (6, 13).

Part I: A pilot study to test the questionnaire instrument was performed in 1994 (13). Questionnaires were sent to all 131 PDHS dentists in one Swedish county (Örebro) and to all 100 PPs in another (Skaraborg). A total of 182 dentists responded to the questions used here, yielding an overall response rate of 79%. Two questions aimed to capture the share of clinical working hours spent on prosthodontics. *A. How many hours per week do you usually work treating patients?* (<15 h, 15–20 h, 21–25 h, 26–30 h, 36–40 h, > 40 h) *B. On the average, what percentage of your clinical time do you use for prosthodontics?* (any percentage figure could be given).

For each dentist, the working hours for prosthodontic care were calculated by multiplying the percentage figure (B) by reported working hours (A), using class means in the categorical responses. The result of this calculation was then compared with a score, calculated from the actually provided services, obtained as follows: a single crown was assigned the unit value of 1.0, a removable denture (RD) the value of 2.5, and a fixed partial denture (FPD) the value of 3.5. These values were determined from an assessment of the time needed for each treatment, based on clinical experience and on the relations between the insurance fees for average single crowns, RDs and FPDs. When dental insurance was introduced in Sweden in 1974, the fees were based on time studies of actual practice (14). The fee for an RD is on average about 2.5 times higher than the fee for a single crown. The most common size of FPDs in this study was 3–4 units. For such an FPD, the fee is approximately 3.5 times higher than for a single crown.

The actual frequencies of the various treatments were obtained from the local county council records for PDHS dentists and weighted with these unit values. This formed a score, the Total Prosthodontic Production Score (TPPS), for the PDHS dentists. TPPS for PPs was obtained in a similar but not identical way, since the county council records do not include PPs. Their production, however, was registered by the Dental Insurance Offices. Unfortunately, this information was not computer registered and had to be handled manually from claims. For practical reasons, the data were only collected for two months (April and May 1994). TPPS was then calculated by multiplying the 2-month value by 5, since a full year's production in Sweden can be estimated to be 10 months (vacation is usually 5–7 weeks). These rather complex calculations can be exemplified as follows: for a PDHS dentist providing 50 single crowns, 20 RDs, and 10 FPDs in the year 1994, the TPPS was calculated as: $(50 \times 1) + (20 \times 2.5) + (10 \times 3.5) = 135$. For a PP with a 2-month production of 15 single crowns, 10 RDs, and 4 FPDs, the TPPS was: $5 ((15 \times 1) + (10 \times 2.5) + (4 \times 3.5)) = 270$.

Part II. In a random sample of all general dentists in Sweden, 28 PDHS dentists from Örebro County and 14 PPs from Skaraborg County had participated in Part I and were also part of the nationwide sample. Because of the experiences of Part I, three specific questions regarding prosthodontic services were added to the Part II

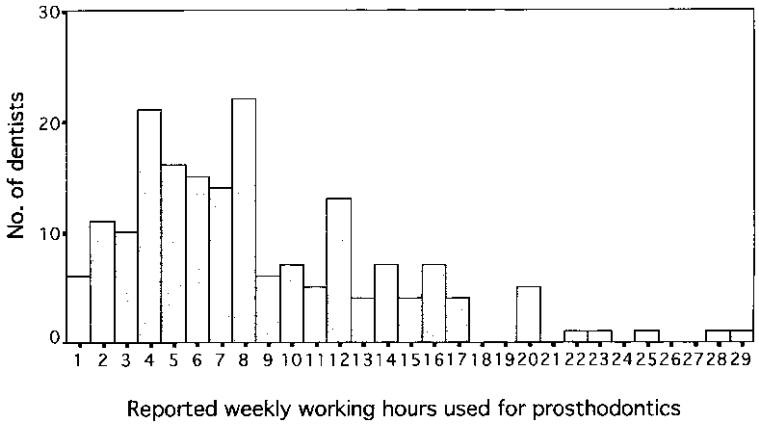

Fig. 1. Frequency distribution of dentists' number of reported weekly working hours spent on prosthodontics. Part I. Histogram, 29 equidistant steps.

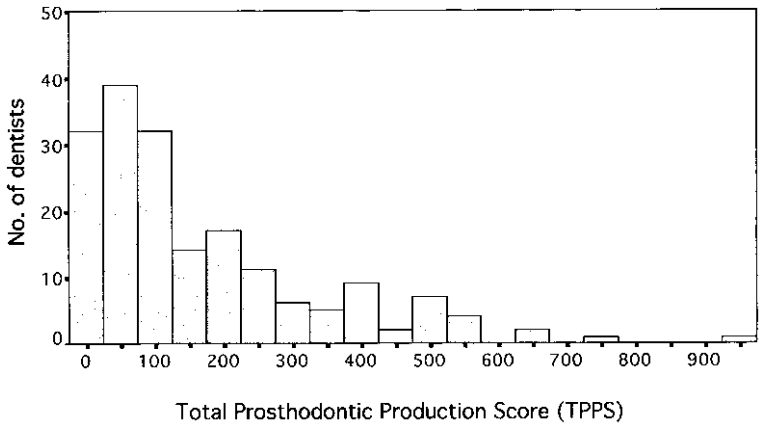

Fig. 2. Frequency distribution of Total Prosthodontic Production Score (TPPS). Part I. Histogram, 20

questionnaire: *On the average, how many removable dentures do you make?* (none, 1–2 per year, 1–2 per month, 3–5 per month, >5 per month). *On the average, how many single crowns do you make?* (none, 1–5 per year, 1–5 per month, 6–10 per month, 11–20 per month, >20 per month). *On the average, how many fixed partial dentures do you make?* (none, 1–2 per year, 1–2 per month, 3–5 per month, 6–10 per month, >10 per month).

The self-assessed frequencies of prosthodontic services were compared to the calculations of those actually performed during 1995, according to data from the county council (for PDHS dentists) and claims made to local insurance offices (for PPs). Data were collected from claims during 4 months (April, May, October, and November). A longer data collection period was possible, since there were fewer PPs than in Part I. Prosthodontic production for the entire year was calculated by multiplying the numbers of the different actually provided services by 2.5 to obtain a 10-month estimate of actual production. The reported and performed services were compared for each kind of service.

In the analysis of part I, the starting point was the distribution of working hours used for prosthodontics and the TPPS. They are presented in histograms and a scatter plot. The two variables were then analyzed in bivariate regression models (15). For part II, the stated and the provided services were analyzed in cross tabulations. The categorizations of actual production frequencies were done as in the questionnaire. The indices for provided services of the different kinds (crowns, FPDs, and RDs) were related to the stated services in three bivariate regression models. The significance of differences was assessed using the chi-square test. The predictive ability of the questionnaire questions was calculated using lambda, a

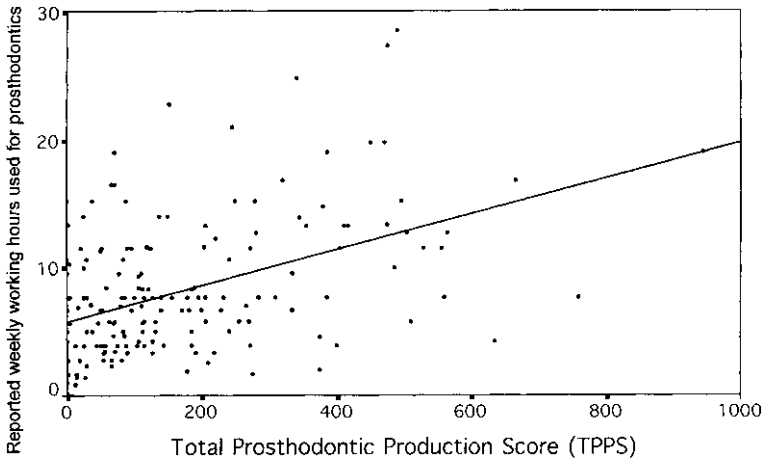

Fig. 3. Scatterplot with regression line. Relation between Total Prosthodontic Production Score (TPPS) and reported weekly working hours spent on prosthodontics.

Table 1. Dentists' weighted actual and stated production of single crowns in Part II. Number of dentists in production categories ($n = 42$)

	Stated no. of crowns					
Weighted actually produced crowns	None	1–5/year	1–5/month	6–10/month	11–20/month	21–/month
None						
1–5/year		1		1		
1–5/month		3	25	4		
6–10/month					7	1
11–20/month						
21–/month						

$P < 0.0001$.
λ actually produced as dependent = 0.80.

Proportional Reduction of Error measure (15). All calculations were done in SPSS.

Results

Part I

The reported weekly working time spent on prosthodontics and the TPPS were described in histograms (Figs. 1 and 2). The two distributions were similarly skewed, but somewhat different in their patterns for low values. The two variables were related to each other in a scatterplot with the regression line included (Fig. 3). The result of the regression analysis (b = 14.8) indicated that if the weekly working time used for prosthodontics were to increase by 1 h, the TPPS would increase by 14.8 units per year, the slope of the regression line in the figure. The explained variance (R^2) was 0.20. The model was significant ($P < 0.0001$). Predicted values were calculated and compared to the actual values of the TPPS. The mean for the predicted values was 164.4 and for the actual values exactly the same. The standard deviations differed, however, and were 76.8 and 170.7, respectively.

Part II

The main study contained specific questions regarding numbers of single crowns, FPDs, and RDs produced. The weighted numbers of actually provided services (single crowns, FPDs, and RDs) were categorized to match the categories in the questionnaire. The results are presented in Tables 1–3.

The correspondence between reported and actually provided services was higher for single crowns and RDs, as indicated by the lambda values. All three tables showed a statistically significant relation between the two variables. Using the uncategorized weighted numbers of the provided services, bivariate regression models were run for all three services, and the results are given in Table 4.

All three models were statistically significant, with a variance explanation about the same as in the Part I model ($R^2 = 0.20$). Predicted values were calculated from the regression models and compared with the actual production in weighted form. The regression coefficients in Table 4 means that for each questionnaire response category the number of units produced per year increased by the regression coefficient. For example, a dentist who reports that he performs 1–5 crowns per month makes on average 10.9 crowns per year more than a dentist who is stating a production of 1–5 crowns per year. For single crowns, the actual production was 25.3 units (s = 20.6). The mean predicted production was almost the same, i.e. 25.6 units (s = 10.5).

Also in Part II, the reported weekly working time spent on prosthodontics covaried with the TPPS, but the association was not as strong as in Part I (b = 2.9, $P = 0.042$, $R^2 = 0.08$). The result indicates that if the weekly working time spent on prosthodontics (independent variable) were to increase by 1 h, the TPPS would increase

Table 2. Dentists' weighted actual and stated production of FPDs in Part II. Number of dentists in production categories ($n = 42$)

	Stated no. of FPDs					
Weighted actually produced FPDs	None	1–2/year	1–2/month	3–5/month	6–10/month	11–/month
None	1	2				
1–2/year	7	12	2			
1–2/month	3	4	4			
3–5/month		2	2	1		
6–10/month			1	1		
11–/month						

$P < 0.0412$.
λ actually produced as dependent = 0.14.

Table 3. Dentists' weighted actual and stated production of RDs in Part II. Number of dentists in production categories ($n = 42$)

	Stated no. of RDs				
Weighted actually produced RDs	None	1–2/year	1–2/month	3–5/month	6–month
None	9				
1–2/year		4	3	1	
1–2/month		7	8		2
3–5/month			7	1	
6–/month					

$P < 0.0001$.
λ actually produced as dependent = 0.40.

by almost 3 units per year. Here, too, the results for predicted and actual values were exactly the same, 58.6 while the standard deviation differed (13.4 and 42.5, respectively).

Discussion

Two questions were asked in the Introduction: 1. Can questionnaire reports of the working hours spent on prosthodontics be used as indicators of actual prosthodontic production? and 2. Do stated service frequencies of different prosthodontic treatments correspond to actually delivered services? Considering the results, a general answer to these questions should be in the affirmative, but with reservations.

The precision in congruence between the two types of measures was fairly low, as can be seen for example in the scatterplot (Fig. 3). The deviation around the average trend, as expressed by the regression line, was wide. This is also indicated by the relatively low explained variance. This would mean that the questionnaire cannot reliably be used for predicting the production of an individual dentist. On the other hand, there is an obvious relation between the two indicators of production, as shown by the regression coefficient. In our view, this makes it possible to use responses to the questionnaire as a production indicator in a population of dentists. Dentists with a high score on one of the variables will, on average, also have a high score on the other variable.

This statement is clearly supported by the noteworthy correspondence between mean predicted values and actual values, which in fact were practically identical. Individual differences are levelled out in a population parameter such as a mean. Already in a material of the present modest size ($n = 42$), this leads to the noted very high correspondence in the predictions yielded by regression models, provided that the models are balanced and unbiased. It can also be noted how regression analysis levels out individual differences if the discrepancies in standard deviations are considered. The predicted values have much lower spread around the mean than the actual values, which is an effect of the regression model. The differences in spread also show that the models are not useful for predicting individual values, but very useful for predicting population parameters such as averages. Furthermore, the TPPS weights, partly based on obsolete data (time studies done 28 years ago) but also adjusted according to clinical experience considering the technical developments since the time studies, introduced a systematic error and increasing variance. Despite this error, the remarkable congruence between predicted and actual values remains, showing the capability and robustness of regression analysis.

The same picture is obtained from the cross tabulations of provided and stated services (Tables 1–3), i.e. on the average a reasonable congruence but lacking individual precision. Few dentists deviated by more than one category and in two of the tables the reported and provided services fell within the same categories for the majority of dentists. A shortcoming in the tables is the artificial categorization of the provided services, where,

Table 4. Regression models for number of units of various types among dentists in Part II ($n = 42$)

	Dependent variables, regression coefficients		
	Registered numbers of		
Independent variables	Single crowns	FPDs	RDs
Reported number of single crowns	10.9		
Reported number of FPDs		3.1	
Reported number of removable dentures			3.2
Adj R^2	0.24	0.18	0.20
P-value	0.0005	0.0029	0.0019

additionally, the categories were not always mutually exclusive. In possible future studies, the categorization should be revised for better discrimination and no overlapping. This shortcoming was amended in the regression analysis, which was based on the actual weighted numbers of provided services. Indeed, the differences illustrate the ex post facto error discussed by Blalock, i.e. the arbitrary manipulation of cut points to fit the desired result (15). In this case, the variables concerned are continuous, and a methodology relevant for continuous variables should be used, i.e. regression analysis.

Discussing measurement, two concepts are fundamental—validity and reliability. Validity usually means what is intended to be measured. Reliability usually means the degree of precision and stability of the used measure (20). In the present study, it is reasonable to believe that the registered production has better validity for actually provided services than responses to the questionnaire, even allowing for the fact that the weighting procedures could have reduced this validity. It is unlikely, however, that services have been provided without being reported in the production registration systems. The time period actually studied was also long enough to cover seasonal variations. Another source of error could be recall bias, where the responses given reflect the recent production of the dentists. This error could be problematic if there is a seasonal variation. According to available data from the PDHS register, no indications were found that such variation is large.

The TPPS score was used as a measure of the total yearly prosthodontic production of each participant. It can, of course, be discussed whether the weighted coefficients used for RDs (2.5) and FPDs (3.5) in relation to single crowns (1.0) were adequate. In Sweden, all PDHS dentists and 99% of the PPs are affiliated to the general dental insurance system, where the fees for the different kinds of treatments are set by the National Health Insurance Board. The fees are adjusted continuously and are the same for all dentists. This insurance system was introduced in 1974 when the fees were based on time studies for every type of treatment (14).

In a situation where one measure is known to have better validity than another, correlation/regression is an adequate method for assessing the validity of the measure with lower validity. Some authors call this the 'construct validity' (15, 18–21). In generalizing population studies, regression analysis levels out deviations from the general trend. On the other hand, reliability and validity are not related to each other. A measure can have good reliability but lack validity, and the converse. In the present study, the precision, i.e. one sense of reliability, is low, while the validity can be considered as adequate for use in a population study.

The present study consists of two parts, both including dentists from the same two counties, PDHS dentists in Örebro County and PPs in Skaraborg County. One could question the representativity of those for the larger population study based on a nationwide random sample. The ideal design, i.e. a random subsample from the larger sample, was not possible for practical reasons. The PDHS dentists from Örebro County and the PPs from Skaraborg County were compared, regarding age and gender, with the rest of the nationwide sample to determine whether they deviated from the total sample. The age and gender distributions were similar, and, using the chi-squared test, there were no statistically significant differences ($P = 0.82$ for gender and $P = 0.94$ for age). There were thus no explicit indications of lacking representativity of the subsamples.

This study gives no support to the contention in the Introduction that the wide reported variations in dentists' decision-making could be artefactual from the used questionnaire measures. The application of questionnaire data is supported here, as in other studies, showing good credibility (8, 9, 12).

In conclusion, the questionnaire data collected in this study can be used as a reasonably valid expression of the prosthodontic activity in population-oriented analyses of prosthodontic decision-making among general dentists.

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