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Revised 15-item Glasgow Benefit Inventory with five factors based on analysis of a large population study of medical and surgical otorhinolaryngological interventions

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Abstract

Objectives: To review, using confirmatory factor analysis, the widely used 18-question Glasgow Benefit Inventory [GBI] that has three factors. Thereafter to develop, using exploratory factor analysis, a more coherent, revised version of the GBI.

Design: Confirmatory and exploratory factor analysis of a large national GBI data set of ORL interventions.

Setting: Adult otorhinolaryngology outpatient clinics in six University Hospital departments.

Participants: One thousand nine hundred eighty adult patients who had complete GBI data and who underwent an active (medical or surgical) intervention, out of the total data set of 9005 patients from the original Scottish ENT Outcome Study [SENTOS].

Results: One of the 18 questions was discarded from the data base because it was not answered by 8% of respondents. Two of the original factors remained (Physical Health, renamed *General Health*, and Social Support, renamed *Support*). The General factor was split into three new factors (*Quality of Life*, *Self-Confidence* and *Social Involvement*). The three new factors were found to give additional information regarding the area of benefit.

This reduced number of questions does not make any material difference to the results of the >196 existing GBI papers in the literature.

Conclusion: A 15-question GBI with five factors is provided that is more explanatory of the areas of benefit.

1 | INTRODUCTION

The Glasgow Benefit Inventory (GBI) is an 18-item questionnaire for measuring patient benefit after otorhinolaryngological (ORL) interventions.[1] It is administered after an intervention has occurred and measures the change in health status, whether that change is positive (benefit) or negative (harm). It was designed to be patient-orientated, sensitive to change after an intervention, and suitable for use in making comparisons between different interventions. Because it does not require any measurement before the intervention was

performed, it is easy to use and adaptable to a variety of clinical situations. Since its original description, the GBI has been used on a range of ORL surgical interventions with Hendry et al reviewing 117 reports with a search date of January 2015.[2] Since then there have been a further 79 publications of surgical series, not only in ORL but facial plastic surgery and ophthalmology [OVID Medline search July 2019 using search terms "GBI" and "Glasgow Benefit Inventory"].

The original report of the GBI in 1996 included a principal component analysis (PCA) that derived three sub-scales: General, Social Support and Physical Health. The practice of statistics has evolved materially since then and there is agreement that while PCA can reduce data by combining variables into a smaller number of components, it is not always effective in understanding the constructs that underlie the data. It therefore should not be used for exploratory factor analysis. The exploratory element requires that as few assumptions as possible are made at the outset about the nature of the factors and the relationship between them, which is not the case for PCA.

In addition, the "General" component in the 1996 analysis is not interpretable as a construct, containing as it does a diverse range of questions with no coherent pattern. The overall GBI scores are the average across all 18 responses. However, a composite total score is only justifiable if the factors all converge. This has not been shown. Given the frequency of use of the GBI in research and clinical contexts, it is critical that the psychometric properties of the instrument are revisited, and if necessary revised.

The Scottish Ear Nose and Throat Outcome study (SENTOS) was a prospective cohort study of 9005 patients attending outpatient ORL clinics at a number of Scottish NHS hospitals.[3] The study involved the administration of two outcome measures: the Health Utilities Index mark 3 (HUI-3) and the GBI. Only the results from the HUI-3 have been reported in detail.[3] GBI questionnaires were completed by 4799 SENTOS participants, giving a data set for analysis which is considerably larger than any other obtained thus far. This gives us an excellent opportunity to reassess the factor structure within the data and to revise the GBI if required.

The purpose of this paper is not to report the many medical and other non-surgical interventions that are common to ORL practice and in SENTOS. These will be reported elsewhere.

2 | METHODS

The aim in this study was primarily to test the stability of the factor structure reported in the original 1996 description of the GBI[1] by using more current, robust statistical methods in a newer large data set.

The data set comprised GBI responses obtained from adult patients (aged 16 years or older) who attended an NHS Academic ORL outpatient appointment and who completed the GBI as part of the SENTOS study. Details of this patient cohort have been published previously.[3]

> **Keypoints**
>
> - The Scottish Ear Nose and Throat Outcome Study [SENTOS] produced a large data set of GBI responses which were used to explore and refine the scoring and reporting of the GBI.
> - Q9 on employment opportunities was unanswered by 8% of participants. As such it should be removed.
> - An exploratory factor analysis then produced a 15-item, five-factor GBI which has been named GBI-5F.
> - The five factors give more information on five different areas of intervention benefit.
> - The reduced number of questions makes no material difference to the results of the >196 existing GBI papers in the literature

Our plan was to perform a *confirmatory* analysis to see whether the original three-factor structure provided an appropriate fit for the data. Should this not provide a good fit for the data, we planned to proceed to *exploratory* factor analysis to uncover whatever underlying variables exist in the data.[4] Further aims of the study were to assess the internal consistency of the item/factor structure and to report methods for calculating and analysing GBI scores.

Confirmatory analysis was performed using principal component analysis, with and without covariance (orthogonal). Exploratory analysis was done using parallel analysis with minimal residual extraction and oblimin rotation.

All analyses were performed using The R Project for Statistical Computing (R Foundation for Statistical Computing, Vienna, Austria). For brevity and ease of reading, only an outline of the statistical methods and results is presented here. Those readers who wish to know more detail are directed to the Appendix S2.

3 | RESULTS

3.1 | Missing SENTOS data

Of the 9005 subjects in SENTOS, 68 were aged 14 or 15 years and therefore excluded as being non-adults. 4799 adults answered at least one of the 18 GBI questions.

Question 9 ("job opportunities") was not answered by 8.3% of participants compared with the 1%-2% for the other seventeen questions. This question could be irrelevant to a large proportion of any study population, particularly those who are retired or not actively seeking employment. The age of participants leaving question 9 unanswered was higher than those who completed it (mean age 67.25 vs 53.16 years, t test, $P < .001$). This is in keeping with an effect of retirement from employment. Its removal from the scores of 3436 adults that had completed question 9 had no material clinical

TABLE 1 Loadings of exploratory factor analysis on full sample (N = 1980)

Item	Question	Quality of life	Self confidence	Support	General health	Social involvement	Factor 6
1	Has the result of your treatment affected the things you do?	**0.64**	0.12			0.13	
2	Have the results of your treatment made your overall life better or worse?	**0.97**					0.28
3	Since your treatment, have you felt more or less optimistic about the future?	**0.42**	0.14				
4	Since your treatment, do you feel more or less embarrassed when with a group of people?		**0.87**				
5	Since your treatment, do you have more or less self-confidence?	0.11	**0.56**				0.36
6	Since your treatment, have you found it easier or harder to deal with company?	0.14	**0.59**				0.18
7	Since your treatment, do you feel that you have more or less support from your friends?			**0.81**			
8	Have you been to your family doctor, for any reason, more or less often, since your treatment?				**0.70**		
10	Since your treatment, do you feel more or less self-conscious?		**0.48**[a]			0.31	
11	Since your treatment, are there more or fewer people who really care about you?			**0.71**		0.11	
12	Since your treatment, do you catch colds or infections more or less often?	0.15			**0.53**		
13	Have you had to take more or less medicine for any reason, since your treatment?				**0.87**		
14	Since your treatment, do you feel better or worse about yourself?	0.23	0.13		0.20	0.23	**0.32**
15	Since your treatment, do you feel that you have had more or less support from your family?			**0.81**			
16	Since your treatment, are you more or less inconvenienced by your ear problem?	0.21				**0.65**	
17	Since your treatment, have you been able to participate in more or fewer social activities?				0.18	**0.38**	0.30
18	Since your treatment, have you been more or less inclined to withdraw from social situations?	−0.10	0.23		0.10	**0.46**	...
	Cronbach's α [95% CI]	0.94 [0.88, 0.99]	0.96[a] [0.93, 0.99]	0.93 [0.88, 0.99]	0.87 [0.76, 0.97]	0.85 [0.72, 0.97]	

Note: Six factors were extracted. Five factors (coloured) were retained.

[a]Improved from 0.92 by removing Q10.

Factor loadings of 0.4 or greater are shown in bold.

effect [total mean score 5.6 ± 17.0 with and 5.7 ± 17.4 without]. Accordingly, question 9 was removed from all further analysis.

3.2 | Categorisation of active interventions

In the data set, interventions were limited to two for each patient: one primary and, where applicable, one secondary intervention. In many instances, a patient had two active interventions that made it impossible to differentiate which intervention was the primary reason for any reported benefit. Middle ear surgery along with provision of a hearing aid is such an example. Accordingly, patients with more than one recorded intervention were evaluated by two authors [GGB and SR] to exclude, in a systematic manner, patients in whom it would be difficult to attribute the benefit to a specific intervention group. This left 3658 patients for analysis. This remains a sufficient number of patients to perform a valid analysis for this paper.

There were two large categories of "reassurance" and "self-management" with a total of 1532 patients. These categories are interesting and warrant further study, but the absence of any active (medical or surgical) intervention means that their reported benefit was small and therefore unhelpful for this study. Excluding this, "reassurance" and "self-management" group leaves a total of 2126 patients who underwent some kind of active intervention. One thousand nine hundred eighty of these had complete GBI data with no missing items. It is their data that form the basis of this study.

3.3 | Confirmatory factor analysis

Our confirmatory factor analysis suggests that the three-factor model originally described in 1996[1] is not a good fit for the data. It appears that not enough factors were properly elaborated, with the General factor derived from nine questions, potentially obscuring multiple dimensions. This makes sense given the large number of heterogeneous questions encompassed by the General factor. We therefore proceeded to a new exploratory factor analysis in order to discern a more acceptable factor structure for our data.

3.4 | Exploratory factor analysis

Parallel analysis suggested six factors be extracted on the active interventions sample of 1980 adults. Four factors clearly met the criteria for retention (Table 1). We reviewed the questions in each factor and interpreted to represent *Quality of Life* (factor 1), *Self-Confidence* (factor 2), *Support* (factor 3) and *General Health* (factor 4). The fifth factor (which we interpret as *Social Involvement*) was found to have two items above the 0.40 loading criterion and one that just fell short of this threshold at 0.38 (Stevens, 1992). Despite just missing the coefficient criterion, the factor had a cogent theme, which we interpreted as *Social Involvement*, and additional information that

TABLE 2 Reliability analysis of the 15 items in the GBI-5F

GBI item	New GBI-5F item	Item total correlation	Cronbach's α if item deleted
Q1	q1	0.626	0.847
Q2	q2	0.637	0.846
Q3	q3	0.643	0.845
Q4	q4	0.612	0.848
Q5	q5	0.667	0.846
Q6	q6	0.644	0.846
Q7	q7	0.326	0.861
Q8	q8	0.439	0.857
Q11	q9	**0.221**	**0.864**
Q12	q10	0.429	0.857
Q13	q11	0.410	0.859
Q15	q12	**0.195**	**0.866**
Q16	q13	0.559	0.851
Q17	q14	0.560	0.851
Q18	q15	0.485	0.854

Note: Shown in bold are the items where Cronbach's alpha increased when the item was deleted.

justified its retention. The sixth factor was discarded due to having only one element (Q14), and that this one question was below the loading criterion (ie was empty). We decided to remove Q14 as it did not load significantly onto any of the first five factors.

Further analysis revealed that the *Self-Confidence* factor could be made more reliable by discarding Q10 (Cronbach's α increase from 0.92 to 0.96).While this is only a small increase in reliability, we decided that the subject matter of Q10 (self-consciousness) was unlikely to be of importance in most otolaryngological interventions. Removing Q10, along with Q9 and Q14 would then result in five factors, each with three question items, and the revised GBI would then be more "balanced" with each question item contributing to the same degree to the overall score and the factor score.

The next analysis was to measure the change in the "Total" GBI scores when the results of questions 10 and 14 were removed in addition to question 9. The Total GBI score with 15 questions was 5.8 ± 17.1, which is not clinically of any material difference from the Total GBI score of 18 questions of 5.6 ± 17.0.

3.5 | Scale reliability

Based on analysis of the full active interventions sample of 1980 patients, Cronbach's α was found to be 0.862. Item total correlations (see Table 2) were all greater than 0.3 apart from two questions in the *Support* factor: Q11 "people really care about you" and Q15 "support from your family." For both of these questions, alpha increased if the item was deleted, although the difference in each case was small. Removing these questions would remove the *Support* factor

entirely so the decision was made to retain them (see Discussion for justification of the inclusion of the *Support* factor).

3.6 | New five-factor Glasgow Benefit Inventory (GBI-5F)

Deleting Q9, Q10 and Q14 leaves us with a new 15-item questionnaire as shown in Appendix S1, with three questions loading onto each of the five factors. The questions are now renumbered *q1-15*, and both question numbers and factor names have been italicised to distinguish them from those in the original version of the GBI. Two of the original factors remain (Physical Health, renamed *General Health*, and Social Support, renamed *Support*). The previous General factor has been split into three new factors (*Quality of Life, Self-Confidence* and *Social Involvement*). The questions comprising each factor are summarised in Table 3.

3.7 | Comparing the original GBI outcomes with the new *GBI-5F* outcomes using two interventions

The distribution of scores for patients who underwent tonsillectomy and first hearing aid fitting in the SENTOS data set is shown in Figures 1 and 2 respectively, with both the old three-factor scores and new five-factor scores for comparison. The rationale for choosing tonsillectomy was that it is a common surgical procedure, which in the

SENTOS study was undergone by 94 patients, mostly young adults (21 male, 73 female; mean age 28.6 years, range 16-76, sd 12.4). GBI scores for tonsillectomy have previously been reported in two studies analysed by Hendry et al[2] allowing for comparison with SENTOS data. The provision of a first hearing aid is another very common intervention in ORL, with 416 patients (198 male, 218 female; mean age 63.7 years, range 20-90, sd 13.7) in the SENTOS database. The benefit of this intervention using the GBI has not previously been reported.

4 | DISCUSSION

4.1 | Synopsis of key findings

- A confirmatory analysis was performed on the original 18-question GBI using a large data set covering all otorhinolaryngological interventions from a prospective, national study.
- One question was removed at the start of the analysis because it had not been completed by 8% of respondents, most likely because the question was about "ability to work." Such a question would not be relevant to a high proportion of ORL patients. Its removal made no material difference to the total GBI score.
- Exploratory factor analysis identified five factors, each consisting of three questions. These were named; *Quality of life, Self-confidence, Social involvement, General Health* and *Support*. The first three were previously combined as the General subscale while the latter two were already sub-scales. Removal of the two

TABLE 3 The factors of the new 15-item GBI-5F

| Question item (original three-factor GBI)	Corresponding question item (GBI-5F)	Old factor (original three-factor GBI)	New factor (GBI-5F)
Q1	*q1*	General	*Quality of Life*
Q2	*q2*	General	*Quality of Life*
Q3	*q3*	General	*Quality of Life*
Q4	*q4*	General	*Self-confidence*
Q5	*q5*	General	*Self-confidence*
Q6	*q6*	General	*Self-confidence*
Q7	*q7*	Social support	*Support*
Q8	*q8*	Physical Health	*General Health*
Q9	[deleted]	General	-
Q10	[deleted]	General	-
Q11	*q9*	Social support	*Support*
Q12	*q10*	Physical Health	*General Health*
Q13	*q11*	Physical Health	*General Health*
Q14	[deleted]	General	-
Q15	*q12*	Social support	*Support*
Q16	*q13*	General	*Social involvement*
Q17	*q14*	General	*Social involvement*
Q18	*q15*	General	*Social involvement*
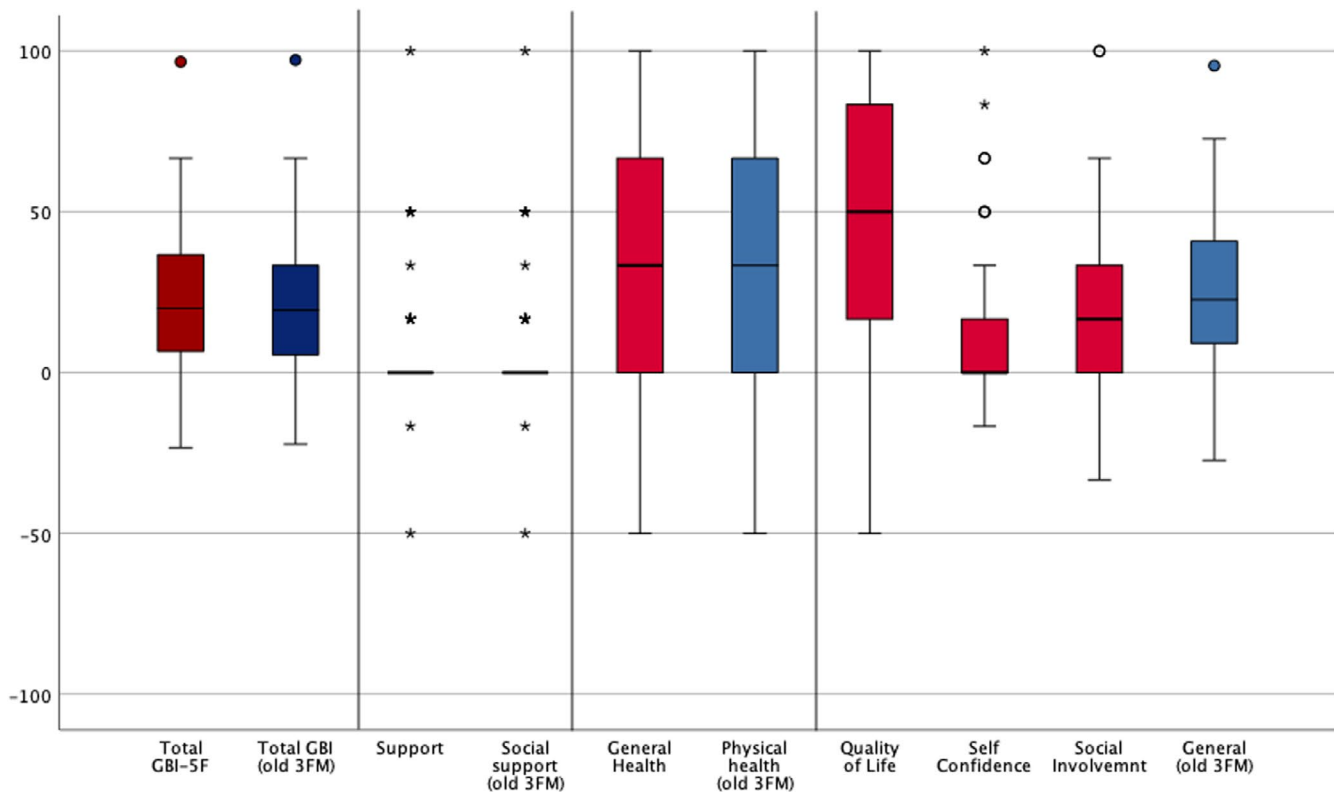
FIGURE 1 The new GBI-5F total and factor scores for patients undergoing tonsillectomy (n = 94) in the SENTOS data set, with the equivalent total and factor scores from the old 18-item, three-factor version of the GBI for comparison. The scores from the new 15-item, five-factor version are shown in red, and those from the old 18-item, three-factor version are shown in blue (and labelled "old 3FM" as an abbreviation for three-factor model). The total scores are shown first on the left. Support is mathematically identical to Social support from the old three-factor model, but we have chosen to rename it. Similarly, General health is mathematically identical to Physical health from the old three-factor model, but again we have renamed it. The General factor score from the old three-factor model has now been broken up into Quality of life, Self-confidence and Social involvement and it can be seen how these add new information. The boxplots show the median and quartiles as the boxes, with the whiskers representing 1.5 times the interquartile range. Outliers beyond 1.5 times the interquartile range are shown as circles and extreme values beyond 2 times the interquartile range are shown as asterisks [Colour figure can be viewed at wileyonlinelibrary.com]

redundant questions made no material difference to the total GBI scores.

- This 15-question, revised version of the GBI with five factors illustrates better the areas of benefit whilst not invalidating previous GBI series.

4.2 | Main implications of implementation of 15 questioned GBI with five factors

The major strength of the new GBI lies in the five-factor structure which provides much richer data for interpretation. Just on the two examples shown in Figures 1 and 2, it can be seen that the pattern of factor scores varies considerably between the two interventions. For example, *General Health* has a large positive effect from tonsillectomy that is absent after hearing aid fitting, as one might expect. That tonsillectomy produces a greater benefit for *Social Involvement* than hearing aid fitting is unexpected and interesting.

4.3 | The overall role of the GBI

The GBI is a "generic" outcome measure, meaning that it does not have any system- or symptom-specific questions. It is often useful, therefore, to accompany it with other condition- or symptom-specific questionnaires.

The main generic alternative for ORL conditions is the SF-36.[5] This was rejected for use in the SENTOS for many reasons. It has eight factors (vitality, physical functioning, general health perception, physical role functioning, emotional role functioning, social role functioning and mental health) the majority of which one would not expect to be modified by the majority of ORL interventions. There is a shorter SF-12[6] that has single questions for these factors and is only able to be reported as a total score. This is not informative of the areas of benefit.

The HUI-3 was used in the SENTOS study alongside the GBI and the results have already been reported.[3] Since the HUI-3 has a specific section on hearing, it is not surprising that significant health benefit was shown for patients undergoing ear surgery or provision
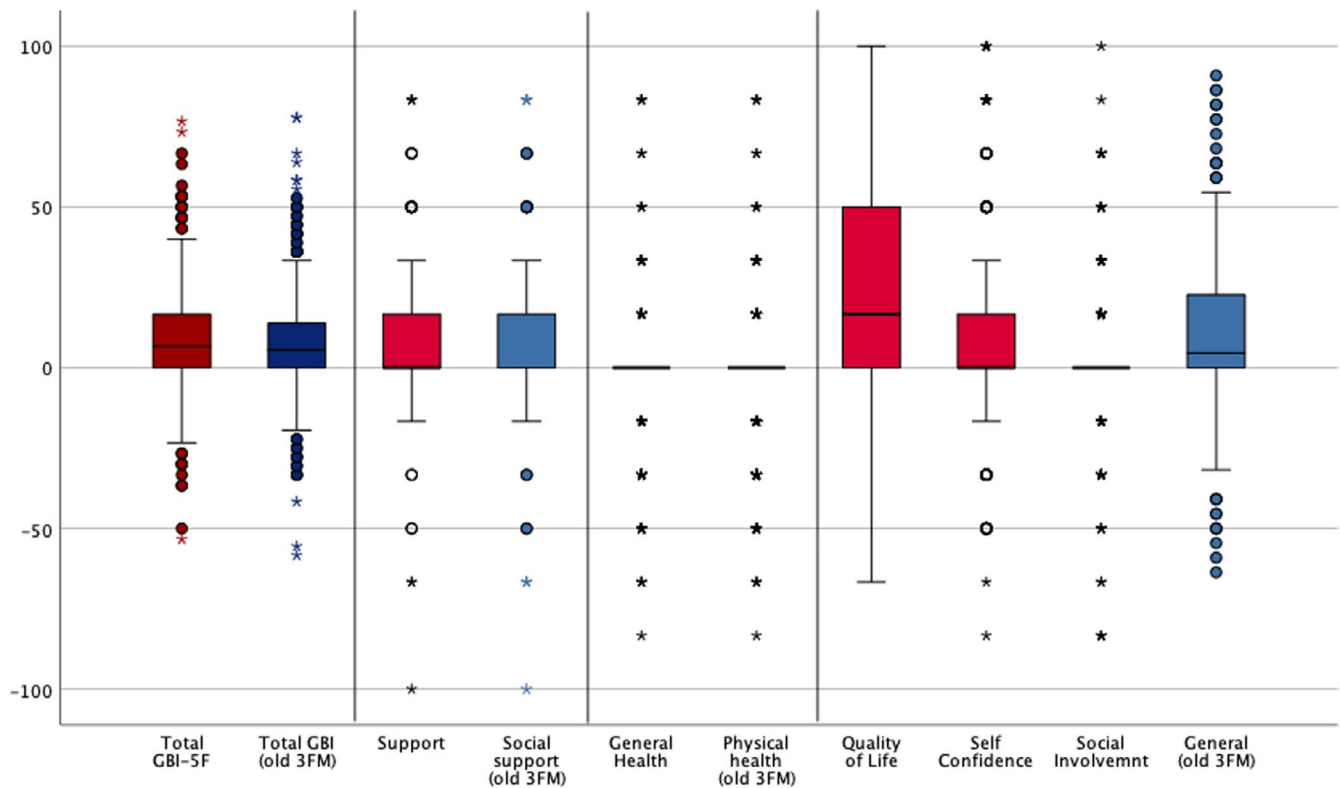
FIGURE 2 The new GBI-5F total and factors scores for patients undergoing their first provision of a hearing aid (n = 416) in the SENTOS data set, with the equivalent total and factor scores from the old 18-item, three-factor version of the GBI for comparison [Colour figure can be viewed at wileyonlinelibrary.com]

of hearing aids. The other areas covered by the HUI-3 relate to attributes that we would not expect to be influenced by ORL interventions (such as vision, ambulation and dexterity), so it is also not surprising that procedures relating to the nose and throat did not show benefit on the HUI-3.[3]

There is a clear need for outcome measures that capture the issues relevant to ORL patients and SENTOS is just one example where an instrument such as the GBI can be particularly useful in capturing information that other generic measures may miss. The large number of studies that have used the GBI in recent years is testament to its perceived usefulness.[2]

It is important, then, that the *GBI-5F* provides reliable and useful information in the individual domains that are contained within it. In seeking to provide a more robust and justifiable factor structure, the risk is of creating a completely new instrument that renders previous studies obsolete or uninterpretable. The *GBI-5F* does not do this. Psychometric rigour is important but needs to be carefully weighed alongside the relevance of the information and the ease of clinical interpretation.

4.4 | Strengths and weaknesses of the study

The SENTOS data set covers a very large number of adult patients (n = 9005) undergoing a wide range of ORL interventions in the

real-world setting of Scottish hospitals. This means that the data can be "messy" with missing information, and overlapping interventions (patients receiving a hearing aid as well as a myringoplasty, for example). However, the volume and breadth of data are such that plenty of meaningful information can be extracted, and even when specific patient groups (such as tonsillectomy) are extracted the numbers are sufficient to be informative.

One weakness in the original, 1996 version of the GBI was the numbering of the questions. The questions were not randomly placed. As a consequence, the questions comprising each of the five factors tend to be grouped together. For example, *Quality of life* comprises *questions 1, 2 and 3*, *Self-confidence* comprises *questions 4, 5 and 6*, and *Social involvement* comprises *questions 16, 17 and 18*. This proximity of questions can lead to bias and randomising the order of the 15 questions in the five-factor updated GBI-5F was considered. Though perhaps desirable, doing so would make comparison with earlier GBI reports based on 18 questions very difficult. A decision was made to keep the 15 questions in their original order from 1996, but renumber them and use italics in order to distinguish the old from the new. This is one example where we have had to make a decision based on a balance of clinical usefulness and psychometric rigour.

Another example of this balance came in decision-making about the factor *Social involvement*. This factor only had two questions with factor loadings of 0.4 or higher, and one with a factor loading of 0.38. Strictly speaking, this just fails to meet commonly

accepted criteria for a robust factor but we made the decision to keep *Social involvement* because we feel that it contains information that is useful and informative in a clinical context. As an example, it can be seen from Figures 1 and 2 that tonsillectomy produces some improvement in *Social involvement* in a way that hearing aid provision does not. This is unexpected and worthy of further study.

The factor *Support* is also of concern from a psychometric point of view, in that two of its three questions have a poor correlation with the remainder and the overall internal consistency of the GBI would be improved by their removal. This would remove the *Support* factor completely, which is something we have decided not to do for two reasons. Firstly, it would change the GBI so fundamentally that any comparison with previous studies would be impossible, and the existing body of literature using the GBI would be, to some extent, invalidated. The second, and more important, reason is that the *Support* factor contains useful, clinically relevant information, as demonstrated by studies of vestibular schwannoma, where the only area to show improvement after treatment is *Support*.[2]

The fact that the *Support* factor contains two questions items that have a poor correlation with the remaining items suggests that the total *GBI-5F* score should be used with caution because the data do not support the assumption that all questions relate to a single, coherent, underlying concept of "benefit." There is a richness of information in the five factors which should be reported separately. Clinicians find a total score intuitive and every published paper so far has reported a total score, so it is likely that it will continue to be used, but we would suggest that the emphasis should always be on the factor scores.

4.5 | Advantages of the new five-factor structure

When we examine Figure 1 using the original three-factor analysis, it can be seen that the main benefit of tonsillectomy is an improvement in General Health with no real change in the Support score. These two factors remain in the new five-factor analysis, but the previous General factor is broken down into three new factors of *Quality of Life*, *Self-confidence* and *Social involvement*. This adds information that, along with their better general health, they become more socially involved. As younger people (mean age of 29 years), the lack of benefit regarding self-confidence and the gaining of more support from others can be noted, as it might not have been anticipated.

Figure 2, on the other hand, shows the effect of hearing aid provision and in the old three-factor analysis, there is a wide range of change in the subjects' General Health over 6 months, as would be expected considering their average age. There is a modest improvement in Support but with a wide range both positive and negative. Whether these changes are similar to those that have not been provided with a hearing aid can be explored by having a control group. This should be studied further. The General score is positive but with

a considerable range. The addition of the three new factors is much more interesting in that *Quality of Life* is the main area of improvement, along with some improvement in *Self-Confidence*. Surprisingly *Social involvement* does not improve, which is regrettable but worthy of further study.

Two of the three previous factors remain with slight changes to their titles; Physical Health becomes *General Health* and Social support becomes *Support*. These two factors have been recognised from previous GBI publications to be important and informative: improvement in Physical Health/*General Health* is the main benefit of tonsillectomy and Social Support/*Support* is the only aspect of the management of vestibular schwannomas that is positive.[2] These two factors are calculated in exactly the same way from exactly the same question items and the only change is to their names. Thus, they can be compared directly to their corresponding factor scores from previous publications.

The value of the original General factor has not been obvious in studies done thus far. It tends to simply mirror the total score because it contains such a large proportion of the questions in the GBI (nine out of the total 18). It is also difficult to interpret as a single meaningful concept with clinical relevance because of the range of issues covered by the nine questions it comprises. This paper recommends that these nine questions be used instead to report three new factors: *Quality of life*, *Self-confidence and Social involvement*. Figure 1 (tonsillectomy) and Figure 2 (provision of first hearing aid) illustrate how doing a five-factor analysis gives additional, meaningful information on the specific areas of benefit (and lack thereof) in these different interventions, particularly in *Self-confidence* and *Social involvement*. The value of the *Quality of life* factor will be more fully explored in forthcoming work reporting a five-factor analysis of the GBI in many of the non-surgical interventions in ORL.

An important benefit of the new, shorter *GBI-5F* is that removing Q9 eliminates a major source of incomplete data as patients not in current employment often struggled to know how to complete the item and therefore left it blank. Many then failed to complete the rest of the questionnaire, resulting in large amounts of missing data.

4.6 | Clinical applicability of the study: recommendations for reporting the GBI-5F

1. If an 18-question GBI has been used, it should be reduced to a 15 question *GBI-5F* with the deletion of Q9, Q10 and Q14 and consequent renumbering of the remaining question items in italics *q1-15* (Appendix S1 and Table 3).
2. With *GBI-5F* questionnaires, the data are unlikely to be normally distributed, so the mean and standard deviation are unlikely to be good descriptors for the data. The factor scores are reported as medians with quartiles and ranges.
3. Total *GBI-5F* scores should be used with caution if at all. The emphasis should be on reporting the benefit scores for each of the

five factors and interpreting these individually and alongside each other.

4. If comparisons require to be made between the original three-factor GBI and the new *GBI-5F* (for example, in a systematic review), then the following guidance can be followed. The 15-item total score (still scaled from −100 to +100) differs little from the total 18 item score and all previous studies reporting total scores can still be interpreted and compared. The fifteen individual question items retained in the *GBI-5F* have not been changed in any way and can still be directly compared, as can the two factors *Support* (which is identical in all respects except name to Social support in the original GBI) and *General Health* (which is identical in all respects except name to Physical Health in the original GBI). The three new factors *Quality of life*, *Social involvement and Self-confidence* should be reported where available. Taking the arithmetic mean of these three new factor scores will produce a close approximation to the old General factor from the original three-factor GBI if such a comparison needs to be made.

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CONFLICT OF INTEREST

None of the authors has any conflict of interest to declare.

AUTHOR CONTRIBUTION

GGB initiated analysis, supported the development of the different themes in interpretation and wrote substantial parts of the paper. HK vetted previous analyses and re-performed many of these using stricter criteria. He was substantially involved in writing the results and discussion section of the paper. WW reviewed the analyses and contributed to writing the paper.

ETHICAL APPROVAL

This is a reanalysis of previously collected data from a large multi-centre study (SENTOS) which was done with Scottish Multi-centre Research Ethics approval. All data are anonymised. No new approvals are required for this study and it raises no new ethical issues.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.