Predictors of weight discussion in primary care consultations: A multilevel modelling approach

Calum T McHale [a] *

Anita H Laidlaw [a]

Joanne E Cecil [a]

[a] School of Medicine, University of St Andrews, St Andrews, UK

* Corresponding author: School of Medicine, University of St Andrews, North Haugh, St Andrews, United Kingdom, KY16 9TF. Email: ctm2@st-andrews.ac.uk

Abstract

Objective*:* To understand how primary care weight-related communication processes are influenced by individual differences in primary care practitioner (PCP) and patient characteristics and communication use.

Methods*:* Two multilevel logistic regression models were calculated to predict the occurrence of 1) weight-related discussion and 2) weight-related consultation outcomes. Coded communication data (Roter Interaction Analysis System) from 218 video-recorded consultations between PCPs and patients with overweight and obesity in Scottish primary care practices were combined with their demographic data to develop the multilevel models.

Results*:* Weight-related discussions were more likely to occur when a greater proportion of PCP's total communication was partnership building and activating communication. More discrete weight discussions during a consultation predicted weight-related consultation outcomes. Patient BMI positively predicted both weight-related discussion and consultation outcomes.

Conclusion*:* This work demonstrates that multilevel modelling is a viable approach to investigating coded primary care weight-related communication data and that it can provide insight into the impact that various patient and PCP factors have on these communication processes.

Practice Implications: Through the increased use of partnership building and activating communications, and by engaging in shorter, but more frequent, discussions about patient weight, PCPs may better facilitate weight-related discussion and weight-related consultation outcomes for their patients.

1 Introduction

Overweight and obesity is a global public health emergency, with over 1.9 billion adults estimated to have an overweight body mass index (BMI) [1]. Overweight and obesity are known to place individuals at higher risk of multiple chronic health conditions [2-4] and mortality [5]. In the UK, primary healthcare services are the first point of contact that most people will have with the health service, offering the opportunity for continuity of care. As such primary care practitioners (PCPs) are well placed to discuss weight issues with their patients. National UK clinical guidelines state that primary care has a responsibility to identify overweight and obesity in their patient population, and offer support or access to weight management if necessary [6, 7]. However there is strong UK-based evidence that weight issues are seldom discussed routinely during primary care consultations [8-12], and that many perceived and structural barriers to effective weight discussion and management exist, including patient motivation and engagement, limited time in consultations, and lack of referral options [13-17].

Previous research examining weight discussion and management approaches in primary care has shown that specific communication approaches, such as PCP use of behaviour change counselling, motivational interviewing and empathy, can facilitate effective weight discussions and tangible weight-related outcomes for patients, including actual weight loss [18]. Work from our research group, employing direct observation (i.e. video recording) to examine weight-related communication within primary care consultations, highlights the importance of patient-centred communication for initiating discussions about patient weight and the implications for positive weight-related consultation outcomes [9, 10, 14, 19].

Patient-centred communication is broadly defined as communication that is respectful of patients' own understanding, circumstances and needs, and aims to develop an equal partnership between practitioner and patient, which involves patients fully in their own healthcare decisions [20, 21].

Data collected within primary care communication research typically has a hierarchical or nested structure, whereby many patients are seen by the same PCP [22]. Multilevel modelling is a statistical regression analysis approach that controls for this type of data clustering, allowing for a more statistically robust analysis of these data, however this approach often requires large dataset [23]. The volume of data typically produced by comprehensive healthcare communication coding approaches, as well as the clustered structure of healthcare consultations, make multilevel modelling a viable approach to investigate healthcare communication patterns and processes. A significant advantage to implementing multilevel modelling into communication analysis is the ability to integrate contextual variables into the analysis [24]. Previous research has attributed differences in healthcare communication to variability in patient and healthcare practitioner demographic, psychological and cultural characteristics [25-27]. Multilevel modelling approaches have previously been employed to examine patient-practitioner communication in a variety of clinical settings, including oncology [28], dentistry [29], and primary care [22, 30, 31]. However, multilevel modelling has yet to be used specifically to examine weight-related communication process in primary care consultations.

This paper reports the results of two multilevel statistical models developed as part of our previous research to investigate weight-related communication processes in routine primary

care consultations [9, 14]. The aim of conducting this analysis was to understand how primary care weight-related communication processes may be influenced by variations in factors at different 'levels' within the hierarchy of a primary care consultation, specifically individual differences between patients and PCPs, thereby gaining a more comprehensive insight into these complex communication processes. Two multilevel models were designed to investigate what patient and PCP factors (communication and characteristics) may predict 1) the occurrence of weight discussion within a routine primary care consultation and 2) the occurrence of a weight-related consultation outcome during a routine consultation that contained weight-related discussion.

2 Methods

2.1 Study design and sample

The data used in this analysis were collected as part of a multi-method observational research study, investigating weight-related communication processes in primary care consultations. The detailed methodology and findings of this research have been published previously [9, 14]. In brief, routine primary care consultations between patients and PCPs, within seven NHS Scotland primary care practices, were video recorded. Patient's height (m) and weight (kg) were measured following each recorded consultation, and their BMI (kg/m^2) was calculated. Participating patients and PCPs also completed questionnaires relating to demographic data and their beliefs about weight issues and weight management in primary care. To avoid biasing consultation communication toward weight discussion, the research focus on weight communication was not disclosed to participants prior to data collection, and participation was not restricted on the basis of BMI. The allotted time for routine consultations within most of the participating practices was 10 minutes, except for one practice that allowed 15 minutes for routine consultation.

For the purposes of this research, weight discussion was defined as any mention of weight during the consultation, regardless of whether it was ignored by the listener, mentioned indirectly whilst discussing another health issue and/or subsequently discussed more fully. As such, multiple discreet weight discussions could be coded during a single video recorded consultation. A weight discussion was considered discreet from another weight discussion if it was separated by communication that was not related to weight, i.e. weight discussions were separated by communication content rather than time. The occurrence of a weight-related consultation outcome was also coded for each video recorded consultation. A

weight-related consultation outcome was defined as any direct counselling message from the PCP that the patient had overweight or obesity and/or the patient should act regarding their weight, a referral onto other services as a direct result of a weight issue, or any clear declaration from the patient that they intended to take action about their weight [9].

The observed communication within video recorded consultations was coded by CTM for all consultations including patients with overweight and obesity using a modified version of the Roter Interaction Analysis System (RIAS) [32] and a novel coding scheme, the St Andrews Interaction Analysis System (SAIRAS) [9]. Only RIAS coded data were included in this analysis. RIAS codes are organised into functional groups, including: information provision, data gathering, emotional expression and responsiveness, partnership building and activating, and procedural [33]. The information provision functional group reflects PCP communication that inform, educate and counsel patients, and reflects patient communication that provide information to the practitioner in a variety of health-related contexts. The data gathering (or question asking for patients) functional group includes open and closed ended questions. The partnership building and activating functional group represent PCP communication that encourage the patient to engage actively in the consultation discussion and in their healthcare decisions. For patients, 'activation' reflects communication that take control of the discussion within the consultation or request specific services from the practitioner. The emotional expression and responsiveness functional group represents patient and PCP communication that have an affective quality, including concern, empathy, reassurance, and criticism, and contains communication that demonstrate understanding or agreement with the other speaker. Finally, the procedural functional group is exclusive to PCPs and contains

communication that facilitate progression through the consultation and/or direct patients during examinations and procedures.

2.2 Analysis – structure and calculation of multilevel models

Two multilevel logistic regression models were calculated, both with binary outcome variables. The outcome variable for model 1 was whether there was any weight discussion during a consultation (yes=1, no = 0). The outcome variable for model 2 was whether a consultation that contained weight discussion had a weight-related consultation outcome for the patient (outcome = 1, no outcome = 0). Construction of the models combined coded communication frequency data from the RIAS coding of the full consultation and data from PCP and patient questionnaires. Model 1 was calculated with data from all consultations with patients with overweight and obesity, and model 2 was calculated with data from the consultations that contained weight-related communication only. Both models were two-level logistic regression models: patients (level 1) were nested within PCPs (level 2). Level 1 explanatory variables were patient and PCP RIAS communication functional group frequencies (i.e. counts of individual RIAS codes grouped according to their function), consultation duration in seconds, number of distinct weight discussions during the consultation (Model 2 only), and patient characteristics. Level 2 explanatory variables in both models were PCP characteristics and whether PCPs had previous weight-related training (Model 1 only). See Table 1 for an overview of the variables within each model.

[Table 1]

Null models were calculated to determine the random intercept and the proportion of the variability, within the outcome variable, that was explained by the clustered structure of the data (i.e. PCP level/between-PCP differences). Initial regressions were then calculated, one included patient communication frequencies as explanatory variables, the other including PCP communication frequencies as explanatory variables. Consultation duration was included as a control variable in model 1, and weight discussion duration was included with the weight discussion communication frequencies as control variables in model 2. Level 1 explanatory variables were then entered into the models (patient BMI, gender, employment status, and education), followed by level 2 PCP control variables (PCP BMI, gender, years in primary care practice, and previous weight-related training). Statistically significant explanatory variables were retained and carried forward to the next regression in the model. Likelihood ratio tests were conducted to compare each regression in the model to the null regression and, if possible, the previous regression, to assess improvement in the predictive ability of the model. Explanatory variables were entered into the multilevel models in meaningful groups to prevent overfitting the models [34]. All multilevel modelling was conducted in STATA/IC 15.0 using the *xtmelogit* procedure [35].

3 Results

3.1 Sample

Overall, 305 patients and 14 PCPs (12 GPs and 2 practice nurses) participated in our primary care weight-related communication study [9, 14]. Two hundred and eighteen patients had an overweight a BMI consistent with overweight (≥ 25 kg/m^2) and 94 patients had an obese a BMI consistent with obesity (≥ 30 kg/m^2). Only data from patients with overweight and obesity were included in this analysis. Of these 218 consultations with patients with overweight and obesity, only 54 consultations contained any weight-related communication. Each consultation was with a different patient. One hundred and fourteen patients were female (52.2%) and 178 (70.6%) of patients were aged 35 years or older. Eight PCPs were male (57.1%) and 13 (92.8%) were aged 35 years or older. A detail description of all participant characteristics and coded communication data have been published previously [9, 14].

3.2 Predictors of weight discussion (Model 1)

Model 1 predicted the occurrence of weight discussion and was calculated using data from all 218 consultations with patients with overweight and obesity (Table 2). Overall, only 3.36% of the variability in whether weight was discussed during a consultation was explained by between-PCP differences in the null model (Model 1.0), indicating high variability between patients who saw the same PCP (within-PCP). Patient communication use during consultations was not found to predict the occurrence of weight discussion during a consultation (model 1.1), however model 1.1 was found to have improved predictive ability when compared with the null model (LR2: χ^2 (5) = 12.83, p = 0.02). PCP partnership building

and activating communication use was found to significantly predict the occurrence of weight discussion during consultations with patients with overweight and obesity (Model 1.2; OR = 1.02, $p < 0.05$), indicating that the odds of weight discussion occurring during a consultation were 2% greater with each coded occurrence of a PCP partnership building and activating communication during the consultation. No other PCP communication use was found to significantly predict the occurrence of weight discussion during a consultation (Model 1.2).

The predictive effect of PCP partnership building and activating communication use was preserved when level 1 control variables were entered in model 1.3 (OR = 1.03, $p < 0.001$), and when level 2 control variables were entered in model 1.4 (OR = 1.04, $p < 0.001$) and model 1.5 (OR = 1.04, $p < 0.001$). Model 1.3 found that both patient BMI (OR = 1.09, $p < 0.01$) and the patient being unemployed (OR = 0.19, $p < 0.05$) significantly predicted the occurrence of weight discussion during a consultation. The odds that a consultation would contain weight discussion were 9% greater with each unit increase in patient BMI, and patients who were unemployed were 81% less likely to have weight discussion occur during their consultation than employed or retired patients (Model 1.3). The predictive ability of model 1.3 was significantly improved when compared with the null model (LR2: $\chi 2$ (5) = 22.0, p = < 0.001). The predictive effect of both patient BMI and patient unemployment were maintained when controlling for Level 2 PCP variables in model 1.4 (BMI: OR = 1.08, $p < 0.01$; Unemployment: OR = 0.21, $p < 0.05$) and model 1.5 (BMI: OR = 1.08, $p <0.01$; Unemployment: OR = 0.19, $p < 0.05$). No level 2 PCP control variables were found to significantly predict the occurrence of weight discussion within a consultation (Model 1.4 and 1.5), however both models had a significantly improved predictive ability when compared with the null model (Model 1.4: χ^2 (6) = 22.27, $p <0.01$; Model 1.5: χ^2 (7) = 23.94, p = 0.001).

[Table 2]

3.3 Predictors of a weight-related consultation outcome (Model 2)

Model 2 predicted the occurrence of a weight-related consultation outcome for the patient and only used data from the 54 consultations containing weight discussion (Table 3). The inter-correlation coefficient indicated that 27.23% of the variability in whether the consultation had a weight-related consultation outcome was explained by between-PCP differences (model 2.0). Additionally, calculating the null model with these data significantly improved the predictive ability of the model, compared with a standard, single-level regression model (model 2.0 LR1: χ^2 (1) = 2.57, p = 0.05). Neither patient or PCP communication use during weight discussion, or the total duration of weight discussion during a consultation, significantly predicted a weight-related consultation outcome (model 2.1 and 2.2). The proportion of the variability in the Model 2 outcome variable that was explained by between-PCP differences increased markedly in model 2.1 (42.46%) and model 2.2 (49.44%) due to level 1 explanatory variables (i.e. differences in patient and PCP communication) explaining variability within-PCP.

When level 1 control variables were entered into model 2.3, it was found that the number of discreet weight discussions during a consultation significantly predicted whether the consultation would have a weight-related consultation outcome (OR = 2.74, $p < 0.05$), indicating that each additional discreet weight discussion within a consultation increased the odds of a weight-related consultation outcome by 2.74 times. The mean length of each

discreet weight discussion was 30 seconds (ranging from 2 to 330 seconds). Additionally, model 2.3 also calculated that patients' BMI significantly predicted whether a consultation had a weight-related consultation outcome (OR = 1.15, $p < 0.05$), indicating that the odds of a weight-related consultation outcome increased by 15% for each unit increase in patient BMI. Model 2.3 was found to have significantly improved predictive ability over model 2.2 (LR3: χ^2 (1) = 14,92, $p < 0.001$).

Introduction of level 2 variables in model 2.4 found that both PCP gender (OR = 0.01, $p < 0.05$) and the length of time that a PCP had worked in primary care (OR = 0.98, $p < 0.05$) significantly predicted whether a consultation had a weight-related consultation outcome. Patients who discussed weight with a female PCP had only a 1% chance of a weight-related consultation outcome, and the odds of a weight-related consultation outcome reduced by 2% for each month that a PCP had worked in primary care, relative to the PCP who had worked in primary care the shortest amount of time. The predictive effect of level 1 explanatory variables, number of discreet weight discussions in a consultation (OR = 4.27, $p < 0.05$) and patient BMI (OR = 1.13 $p < 0.05$), remained statistically significant in model 2.4. Model 2.4 had significantly improved predictive ability over the null model (LR2: χ^2 5) = 11.54, $p <0.05$) and model 2.3 (LR3: χ^2 (1) = 9.98, $p =0.001$).

[Table 3]

4 Discussion and conclusion

4.1 Discussion

This analysis applied a multilevel modelling approach to PCP and patient communication and demographic data to gain a more comprehensive insight into primary care weight-related communication processes and how they may be influenced at both the patient and PCP level. To our knowledge this is the first time a multilevel modelling approach has been applied specifically to investigate weight-related communication processes in primary care consultations. Our calculation of two multilevel logistic regression models highlighted several key findings relating to likelihood of weight discussion within a primary care consultation. Weight discussion was more likely to occur during consultations with patients with overweight and obesity when a greater proportion of the PCP's total consultation communication was partnership building and activating communication. Weight discussion was also more likely to occur as patient BMI increased, however patient unemployment significantly reduced the odds that weight would be discussed during a consultation. For consultations that contained weight discussion, patient and PCP communication use during weight discussion was not predictive of a weight-related consultation outcome for the patient. However, a positive predictive relationship was found between the number of individual weight discussions during a consultation and a weight-related consultation outcome. Finally, increased patient BMI was predictive of a weight-related consultation outcome, but weight-related consultation outcomes were significantly less likely when the PCP had worked in primary care for longer and when the PCP was female.

Partnership building and activating is a PCP communication approach that aims to encourage patients to speak and engage actively in consultation discussions, thereby demonstrating

attentiveness to and facilitation of patients understanding of the discussion topic [33]. Such communication approaches fall within the broadly defined healthcare communication approach known as patient-centred communication [36, 37]. Patient-centred communication is the recommended communication approach in primary care [38] having been associated with numerous positive patient outcomes, including patient satisfaction, understanding and adherence to treatment [39-43]. Specifically related to this analysis, previous research examining the influence of patient-centred weight-related counselling approaches in primary care found that PCP use of such approaches was associated with an increased desire to lose weight and with actual body weight loss in patients [44-46]. Our findings support and extend this research by suggesting that the use of a patient-centred communication approach may be important, not just when actively counselling patients about weight issues, but also for initiating discussions about patient weight in the first place.

Our data showed that patient BMI predicted the occurrence of weight discussion as well as a weight-related consultation outcome. This finding is consistent with previous primary care research that found increasing patient BMI to be a predictor of PCPs identifying and informing patients that they have overweight or obesity, and of them providing specific advice to lose weight to those patients with overweight or obesity [47]. It is well established that the risk of mortality and the development of co-morbid health issues increases with BMI [48, 49], therefore it is expected that, as patient BMI increases, it becomes an progressively salient issue for discussion in primary care consultations. Despite this, weight-related discussion and weight-related consultation outcomes were scarcely observed in our sample. Only 25% of consultations with patients who had an overweight or obese BMI had any weight discussion in their consultation, and only 25% of those consultations had a weight-related

consultation outcome for the patient [9]. Routinely delaying discussions about weight issues until they become significant and possibly symptomatic conflicts with national clinical guidance [6, 7] and the current public health priorities outlined by the Scottish Government, which focus on healthy weight and disease prevention [50]. PCPs perceive many barriers to weight discussion and management [13-17] and NHS weight management provision in Scotland is known to be variable and accessible only to patients with established obesity and/or symptomatic weight issues. [51]. Many of these barriers were also reported by PCPs in our sample [14]. PCPs need to be better supported, through *communication* training focused on raising the topic of patient weight through the use of partnership building and activating and systemic change (such as standardising and widening access to NHS weight management services in Scotland), to more confidently and positively engage in preventative weight-related discussions and weight management approaches with patients.

Patient employment status and level of education were used as proxy measures of patient socioeconomic status (SES) in this research. In the UK, individuals from lower SES groups are more likely to be overweight or obese compared with individuals from higher SES groups [52, 53]. Previous research highlights a "social gradient" in patient healthcare communication experiences [54]. A systematic review of studies investigating the relationship between SES and medical communication, found that patients from lower SES groups experienced less information giving, socio-emotional expression, and partnership building communication from PCPs, compared with patients from higher SES groups [55]. Our finding, that weight was less likely to be discussed in consultations with unemployed patients, may be the consequence of patients from lower SES groups experiencing less PCP partnership building and activating communications, which we found predicted weight discussion occurrence

during a consultation. This finding suggests potential socioeconomic inequalities in weight discussion and management within primary care services in Scotland.

Patient and PCP communication use during weight discussion was not found to predict whether a consultation containing weight discussion would have a weight-related consultation outcome. This finding was surprising, given that previous research directly investigating weight discussion has identified links between communication approaches during weight discussion and various immediate and longer-term patient weight-related outcomes, including confidence to lose weight, weight loss attempts, and actual weight loss [44-46, 56, 57]. Important differences in study design, between our research and previous work, may explain this divergent finding. Our systematic review of research employing direct observation to investigate weight discussion found that studies have focused primarily on PCP communication approaches, such as counselling techniques [18]. We took a broader approach to communication analysis in our research by examining all consultation communication content, including PCP *and* patient communication, and the context in which weight issues were being discussed [9]. Furthermore, previous studies collected data on longer-term weight-related outcomes (such as actual weight loss) [44-46, 56, 57]. Weight-related outcomes in our study were immediate consultation outcomes determined by the researcher, based on the communication observed during the consultation, including PCP weight counselling messages and/or referral on for additional tests and to services for weight issues [9]. These important differences in how communication and outcomes were defined and assessed make a direct comparison between studies difficult, however it may be that weight-related communication is more predictive of longer-term changes in patients' weight-

related thoughts and behaviours than more immediate weight-related consultation outcomes, such as planning.

We found a positive predictive relationship between the number of discreet weight discussions during a consultation and a weight related consultation outcome, whereas the total time spent discussing weight during a consultation did not predict a weight-related consultation outcome. This was unexpected as our previous analysis identified that mean time spent in weight discussion was significantly greater for consultations that contained a weight-related consultation outcome [9]. These findings contrast with the commonly cited primary care PCP belief that weight is a time-consuming issue to discuss effectively constructively [16, 58, 59]. It should be noted, however, that most weight discussions were brief (mean length of 30 seconds) and weight-related consultation outcomes were rare in our sample. Nevertheless, our findings suggest that longer discussions about weight may not be the most effective approach to addressing discussing weight issues, and that a 'little and often' approach to discussing weight may be more likely to produce a weight-related consultation outcome. This also support the finding of a UK-based randomised controlled trial of a brief communication intervention for obesity, whereby patient with obesity were opportunistically offered a referral onto weight management services by a PCP [60]. Patients found this to be appropriate and acceptable, and patients offered the intervention experienced a greater mean weight loss at 12 months when compared to control patients [60].

Patients who discussed weight with their PCP were significantly less likely to have a weight-related consultation outcome if the PCP was female. There is no existing research

investigating PCP gender and weight discussion and weight-related consultation outcomes in this way, however a study published by Pickett-Blakely, Bleich and Cooper [61] found that male patient-PCP gender concordance was associated with an increased likelihood of receiving weight-related counselling in primary care settings, compared with female patient-PCP gender concordance. Our results may be due to societal perceptions associating physical fitness to masculinity and that male PCPs perceive male patients as more receptive to discussing weight issues [61]. Previous research has also found that male and female PCPs differed in term of practice style [62, 63] and communication use [64-66]. Interestingly, both Roter, Hall and Aoki [65] and Bertakis and Azari [66] found that female PCPs displayed more patient-centred communication with patients than male PCPs. We believe that our finding may potentially be the result of Model 2 being statistically underpowered at the second level due to the small PCP sample and the scarcity of consultations containing a weight-related consultation outcome. As such, these findings cannot be generalised to all PCPs.

Prior to conducting multilevel modelling of our data, more complex models were designed, that included other variables, such as patient and PCP beliefs and attitudes about weight discussion and management in primary care, as explanatory variables. Additional models were also planned in which the model outcome variables were at the communication or utterance level (i.e. individual RIAS codes rather than the functional groups of several RIAS codes), including how each discreet weight discussion was initiated and responded to, and what communication and hierarchal factors may explain this. Unfortunately, the brevity of weight discussion within our video recorded consultation sample limited the weight-related communication content that could be coded and analysed. This reduced the overall size of the dataset and the variability within many of the weight discussion communication

variables. Similarly, sub-group analysis according to who initiated the observed weight discussions (PCP or patient) was not possible in these multilevel models. We have examined the communication process related to weight discussion initiation previously [9]. When attempting to construct models at the communication utterance level, estimations were too small to report, and several regressions would not converge. Therefore, it was decided that multilevel modelling at the utterance level was not appropriate with the chosen model outcome variables and the current dataset. Sample size and lack of variability in some explanatory variables was evidently an issue when constructing model 2, which was subsequently simplified so that the model could be produced. Therefore, model 2 is likely statistically underpowered and a degree of caution should be employed when interpreting or generalising its outcomes. Although there were limitations within the dataset for the purposes of multilevel analysis, the use of multilevel modelling was appropriate and correct from a theoretical perspective because there was clear data clustering within this dataset. We intend this analysis to be a proof of concept for the strengths of multilevel modelling approaches when analysing weight-related communication data, and healthcare communication data more broadly.

4.2 Conclusion

We have demonstrated that multilevel modelling is a viable approach to investigating coded primary care weight-related communication data and that it can provide depth and insight into the impact that various patient and PCP factors have on these communication processes. Through the increased use of partnership building and activating communications, and by engaging in shorter, but more frequent, discussions about patient weight, PCPs may better facilitate weight-related discussion and weight-related consultation outcomes, during

primary care consultations. Social inequalities between patients and PCP gender may have important implications for the weight discussion process, however more research is needed to determine their impact.

4.3 Practice implications

Our analysis indicated that demonstrating attentiveness, encouraging patient participation, and ensuring patient understanding during primary care consultations (i.e. partnership building and activating) may help to facilitate weight-related discussion with patients with overweight and obesity. Additionally, engaging in frequent and shorter weight discussion (as opposed to fewer, longer discussions) may be an effective strategy for producing a weight-related consultation outcome for patients.

Acknowledgements

The authors would like to thank all primary care patients and PCPs who participated and the practice teams for supporting and facilitating the research.

Funding

This research was funded by a University of St Andrews 600th Anniversary Doctoral Scholarship.

Declaration of interest

The authors declare no conflicts of interest.

Reference

[1] World Health Organisation, Overweight and obesity: Fact sheet, 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. [Accessed 1 November 2020].

[2] D.P. Guh, W. Zhang, N. Bansback, Z. Amarsi, C.L. Birmingham, A.H. Anis, The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis, BMC Public Health 9 (2009) 88.

[3] S. Virani Salim, A. Alonso, J. Benjamin Emelia, S. Bittencourt Marcio, W. Callaway Clifton, P. Carson April, M. Chamberlain Alanna, R. Chang Alexander, S. Cheng, et al., Heart Disease and Stroke Statistics—2020 Update: A Report From the American Heart Association, Circulation 141(9) (2020) e139-e596.

[4] M. Kyrgiou, I. Kalliala, G. Markozannes, M.J. Gunter, E. Paraskevaidis, H. Gabra, P. Martin-Hirsch, K.K. Tsilidis, Adiposity and cancer at major anatomical sites: umbrella review of the literature, BMJ 356 (2017) j477.

[5] K.R. Fontaine, D.T. Redden, C. Wang, A.O. Westfall, D.B. Allison, Years of Life Lost Due to Obesity, JAMA 289(2) (2003) 187-193.

[6] Health Improvement Scotland, Scottish Intercollegiate Guidelines Network: 115 - Management of obesity. A national clinical guideline, 2010. https://www.sign.ac.uk/our-guidelines/management-of-obesity/. [Accessed 13 November 2020].

[7] National Institute for Health and Care Excellence, Clinical guideline [CG189] Obesity: identification, assessment and management, 2014. https://www.nice.org.uk/guidance/cg189. [Accessed 13 November 2020].

[8] H.P. Booth, A.T. Prevost, M.C. Gulliford, Access to weight reduction interventions for overweight and obese patients in UK primary care: population-based cohort study, BMJ Open 5(1) (2015) e006642.

[9] C.T. McHale, J.E. Cecil, A.H. Laidlaw, An analysis of directly observed weight communication processes between primary care practitioners and overweight patients, Patient education and counseling 102(12) (2019) 2214-2222.

[10] A. Laidlaw, C. McHale, H. Locke, J. Cecil, Talk weight: an observational study of communication about patient weight in primary care consultations, Primary Health Care Research & Development 16(3) (2015) 309-315.

[11] J.C. McLaughlin, K. Hamilton, R. Kipping, Epidemiology of adult overweight recording and management by UK GPs: a systematic review, British Journal of General Practice 67(663) (2017) e676-e683.

[12] N. Critchlow, G. Rosenberg, H. Rumgay, R. Petty, J. Vohra, Weight assessment and the provision of weight management advice in primary care: a cross-sectional survey of self-reported practice among general practitioners and practice nurses in the United Kingdom, BMC Family Practice 21(1) (2020) 111.

[13] D.N. Blane, P. McLoone, D. Morrison, S. Macdonald, C.A. O'Donnell, Patient and practice characteristics predicting attendance and completion at a specialist weight management service in the UK: a cross-sectional study, BMJ Open 7(11) (2017) e018286.

[14] C.T. McHale, A.H. Laidlaw, J.E. Cecil, Primary care patient and practitioner views of weight and weight-related discussion: a mixed-methods study, BMJ open 10(3) (2020) e034023.

[15] A. Laidlaw, C. Napier, F. Neville, A. Collinson, J.E. Cecil, Talking about weight talk: primary care practitioner knowledge, attitudes and practice, Journal of Communication in Healthcare 12(3-4) (2019) 145-153.

[16] M. Blackburn, A. Stathi, E. Keogh, C. Eccleston, Raising the topic of weight in general practice: perspectives of GPs and primary care nurses, BMJ Open 5(8) (2015) e008546.

[17] A. Dewhurst, S. Peters, A. Devereux-Fitzgerald, J. Hart, Physicians' views and experiences of discussing weight management within routine clinical consultations: A thematic synthesis, Patient Educ Couns 100(5) (2017) 897-908.

[18] C.T. McHale, A.H. Laidlaw, J.E. Cecil, Direct observation of weight-related communication in primary care: a systematic review, Family Practice 33(4) (2016) 327-345.

[19] C.T. McHale, J.E. Cecil, Observing identity: Measuring professional identity empirically in the healthcare professions., in: R. Ellis, E. Hogard (Eds.), Professional Identity in the Caring Professions: Meaning; Measurement and Mastery, Routledge, Oxford, UK, 2021.

[20] R.M. Epstein, R.L. Street Jr, Patient-centered communication in cancer care: promoting healing and reducing suffering, (2007).

[21] S.M. Phelan, B.A. Lynch, K.D. Blake, D. Blanch-Hartigan, R. Hardeman, P. Wilson, M. Branda, L.J. Finney Rutten, The impact of obesity on perceived patient-centred communication, Obesity Science & Practice 4(4) (2018) 338-346.

[22] C. Salisbury, M. Wallace, A.A. Montgomery, Patients' experience and satisfaction in primary care: secondary analysis using multilevel modelling, BMJ 341 (2010) c5004.

[23] S. Rabe-Hesketh, A. Skrondal, Multilevel modelling of complex survey data, Journal of the Royal Statistical Society: Series A (Statistics in Society) 169(4) (2006) 805-827.

[24] K. Jones, C. Duncan, Modelling context and heterogeneity: Applying multilevel models, in: E. Scarbrough, E. Tanenbaum (Eds.), Research Strategies in the Social Sciences: A Guide to New Approaches, Oxford University Press, New York City, NY, 1998, pp. 95-123.

[25] D.L. Roter, J.A. Hall, Physician Gender and Patient-Centered Communication: A Critical Review of Empirical Research, Annual Review of Public Health 25(1) (2004) 497-519.

[26] B.C. Schouten, L. Meeuwesen, Cultural differences in medical communication: A review of the literature, Patient Education and Counseling 64(1) (2006) 21-34.

[27] L.M.L. Ong, J.C.J.M. de Haes, A.M. Hoos, F.B. Lammes, Doctor-patient communication: A review of the literature, Social Science & Medicine 40(7) (1995) 903-918.

[28] J. Kandsberger, S.N. Rogers, Y. Zhou, G. Humphris, Using fundamental frequency of cancer survivors' speech to investigate emotional distress in out-patient visits, Patient Education and Counseling 99(12) (2016) 1971-1977.

[29] Y. Zhou, G.M. Humphris, Reassurance and distress behavior in preschool children undergoing dental preventive care procedures in a community setting: a multilevel observational study, Ann Behav Med 48(1) (2014) 100-11.

[30] P. Davis, B. Gribben, R. Lay-Yee, A. Scott, How much variation in clinical activity is there between general practitioners? A multi-level analysis of decision-making in primary care, J Health Serv Res Policy 7(4) (2002) 202-8.

[31] Y. Zhou, J.M. Lundy, G. Humphris, S.W. Mercer, Do multimorbidity and deprivation influence patients' emotional expressions and doctors' responses in primary care consultations?--An exploratory study using multilevel analysis, Patient Educ Couns 98(9) (2015) 1063-70.

[32] D. Roter, S. Larson, The Roter interaction analysis system (RIAS): utility and flexibility for analysis of medical interactions, Patient Educ Couns 46(4) (2002) 243-51.

[33] D. Roter, The Roter Interaction Analysis System (RIAS): applicability within the context of cancer and palliative care, in: D.W. Kissane, B.D. Bultz, P.M. Butow, I.G. Finlay (Eds.), Handbook of Communication in Oncology and Palliative Care, Oxford University Press, New York City, NY, 2010.

[34] M.A. Babyak, What you see may not be what you get: a brief, nontechnical introduction to overfitting in regression-type models, Psychosom Med 66(3) (2004) 411-21.

[35] StataCorp, Stata Statistical Software: Release 15, StataCorp LLC, College Station, TX, 2017.

[36] M. Stewart, Towards a global definition of patient centred care, BMJ (Clinical research ed.) 322(7284) (2001) 444-445.

[37] R.M. Epstein, R.L. Street, Jr., The values and value of patient-centered care, Ann Fam Med 9(2) (2011) 100-103.

[38] Royal College of General Practitioners, The RCGP Curriculum : Being a General Practitioner 2019. https://www.rcgp.org.uk/training-exams/training/gp-curriculum-overview/document-version.aspx. [Accessed 30th October 2020].

[39] M.A. Stewart, Effective physician-patient communication and health outcomes: a review, Cmaj 152(9) (1995) 1423-33.

[40] S. Williams, J. Weinman, J. Dale, Doctor-patient communication and patient satisfaction: a review, Family Practice 15(5) (1998) 480-492.

[41] P. Little, H. Everitt, I. Williamson, G. Warner, M. Moore, C. Gould, K. Ferrier, S. Payne, Observational study of effect of patient centredness and positive approach on outcomes of general practice consultations, Bmj 323(7318) (2001) 908-11.

[42] N. Mead, P. Bower, Patient-centred consultations and outcomes in primary care: a review of the literature, Patient Educ Couns 48(1) (2002) 51-61.

[43] K.B.H. Zolnierek, M.R. Dimatteo, Physician communication and patient adherence to treatment: a meta-analysis, Med Care 47(8) (2009) 826-834.

[44] M.E. Cox, W.S. Yancy Jr, C.J. Coffman, T. Østbye, J.A. Tulsky, S.C. Alexander, R.J.N. Brouwer, R.J. Dolor, K.I. Pollak, Effects of counseling techniques on patients' weight-related attitudes and behaviors in a primary care clinic, Patient education and counseling 85(3) (2011) 363-368.

[45] K.I. Pollak, S.C. Alexander, C.J. Coffman, J.A. Tulsky, P. Lyna, R.J. Dolor, I.E. James, R.J.N. Brouwer, J.R. Manusov, T. Østbye, Physician communication techniques and weight loss in adults: Project CHAT, American journal of preventive medicine 39(4) (2010) 321-328.

[46] K.I. Pollak, T. Østbye, S.C. Alexander, M. Gradison, L.A. Bastian, R.J. Brouwer, P. Lyna, Empathy goes a long way in weight loss discussions, J Fam Pract 56(12) (2007) 1031-6.

[47] L.R. Simkin-Silverman, K.A. Gleason, W.C. King, L.A. Weissfeld, A. Buhari, M.A. Boraz, R.R. Wing, Predictors of weight control advice in primary care practices: patient health and psychosocial characteristics, Preventive medicine 40(1) (2005) 71-82.

[48] K.V. Narayan, J.P. Boyle, T.J. Thompson, E.W. Gregg, D.F. Williamson, Effect of BMI on lifetime risk for diabetes in the US, Diabetes care 30(6) (2007) 1562-1566.

[49] E. Di Angelantonio, S.N. Bhupathiraju, D. Wormser, P. Gao, S. Kaptoge, A.B. de Gonzalez, B.J. Cairns, R. Huxley, C.L. Jackson, G. Joshy, Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents, The Lancet 388(10046) (2016) 776-786.

[50] Scottish Government, Public Health Priorities for Scotland 2018. https://www.gov.scot/publications/scotlands-public-health-priorities/pages/1/. [Accessed 1st October 2020].

[51] S. Read, J. Logue, Variations in weight management services in Scotland: a national survey of weight management provision, J Public Health (Oxf) 38(3) (2016) e325-e335.

[52] Public Health England, New briefing paper explores inequalities in diet and physical activity, 2013. https://www.gov.uk/government/news/new-briefing-paper-explores-inequalities-in-diet-and-physical-activity. [Accessed 13 November 2020].

[53] Scottish Parliament Information Centre, Obesity in Scotland, 2015. https://www.parliament.scot/parliamentarybusiness/85192.aspx. [Accessed 13th November 2020].

[54] E. Verlinde, N. De Laender, S. De Maesschalck, M. Deveugele, S. Willems, The social gradient in doctor-patient communication, International Journal for Equity in Health 11(1) (2012) 12.

[55] S. Willems, S. De Maesschalck, M. Deveugele, A. Derese, J. De Maeseneer, Socio-economic status of the patient and doctor-patient communication: does it make a difference?, Patient Educ Couns 56 (2) (2005) 139-46.

[56] M.E. Bodner, R.J. Dolor, T. Ostbye, P. Lyna, S.C. Alexander, J.A. Tulsky, K.I. Pollak, Accuracy and congruence of patient and physician weight-related discussions: from project CHAT (Communicating Health: Analyzing Talk), J Am Board Fam Med 27(1) (2014) 70-77.

[57] K.I. Pollak, C.J. Coffman, S.C. Alexander, J.A. Tulsky, P. Lyna, R.J. Dolor, M.E. Cox, R.J.N. Brouwer, M.E. Bodner, T. Østbye, Can physicians accurately predict which patients will lose weight, improve nutrition and increase physical activity?, Family Practice 29(5) (2012) 553-560.

[58] K. Phillips, F. Wood, P. Kinnersley, Tackling obesity: the challenge of obesity management for practice nurses in primary care, Fam Pract 31(1) (2014) 51-9.

[59] A.R. Ruelaz, P. Diefenbach, B. Simon, A. Lanto, D. Arterburn, P.G. Shekelle, Perceived barriers to weight management in primary care--perspectives of patients and providers, J Gen Intern Med 22(4) (2007) 518-22.

[60] P. Aveyard, A. Lewis, S. Tearne, K. Hood, A. Christian-Brown, P. Adab, R. Begh, K. Jolly, A. Daley, A. Farley, D. Lycett, A. Nickless, L.-M. Yu, L. Retat, L. Webber, L. Pimpin, S.A. Jebb, Screening and brief intervention for obesity in primary care: a parallel, two-arm, randomised trial, The Lancet 388(10059) (2016) 2492-2500.

[61] O. Pickett-Blakely, S.N. Bleich, L.A. Cooper, Patient-physician gender concordance and weight-related counseling of obese patients, American journal of preventive medicine 40(6) (2011) 616-619.

[62] K.D. Bertakis, The influence of gender on the doctor-patient interaction, Patient Educ Couns 76(3) (2009) 356-60.

[63] P. Franks, K.D. Bertakis, Physician gender, patient gender, and primary care, J Womens Health (Larchmt) 12(1) (2003) 73-80.

[64] J.A. Hall, J.T. Irish, D.L. Roter, C.M. Ehrlich, L.H. Miller, Gender in medical encounters: an analysis of physician and patient communication in a primary care setting, Health Psychol 13(5) (1994) 384-92.

[65] D.L. Roter, J.A. Hall, Y. Aoki, Physician gender effects in medical communication: a meta-analytic review, Jama 288(6) (2002) 756-764.

[66] K.D. Bertakis, R. Azari, Patient-centered care: the influence of patient and resident physician gender and gender concordance in primary care, Journal of women's health 21(3) (2012) 326-333.

Table 1: Outcome and explanatory variables in each multilevel logistic regression model

Model	Outcome variable	Level 1 explanatory variables	Level 2 explanatory variables

1	Weight discussed during the consultation (1=yes; 0 = no)	• Patient RIAS code frequencies
		  ○ Information provision
		  ○ Question asking
		  ○ Activation
		  ○ Responsiveness and emotion
		  ○
		• PCP RIAS code frequencies
		  ○ Education and counselling
		  ○ Question asking
		  ○ Partnership building and activating
		  ○ Responsiveness and emotion
		  ○ Procedural
		• Consultation duration (seconds)
		• Patient characteristics
		  ○ Body mass index (BMI)
		  ○ Gender
		  ○ Employment status
		  ○ Level of education
			• PCP characteristics
			  ○ Body mass index (BMI)
			  ○ Gender
			  ○ Time in profession (months)
			• PCP previous training
			  ○ Nutrition
			  ○ Obesity
			  ○ Behaviour change
			  ○ Physical activity

2	Consultation had weight-related outcome (1 = yes; 0 = no)	• Patient RIAS code frequencies
		  ○ Information provision
		  ○ Activation
		  ○ Responsiveness and emotion
		  ○
		• PCP RIAS code frequencies
		  ○ Education and counselling
		  ○ Partnership building and activating
		  ○ Responsiveness and emotion
		  ○ Procedural
		• Consultation duration (seconds)
		• Number of distinct weight discussion
		• Patient characteristics
		  ○ Body mass index (BMI)
		  ○ Gender
		  ○ Level of education
			• PCP characteristics
			  ○ Body mass index (BMI)
			  ○ Gender
			  ○ Time in profession (months)

Table 2: Two-level logistic regression model with the binary outcome variable, weight discussed during consultation (0 = No, 1 = Yes)

	Model 1.0 (Null model)	**Model 1.1** (Patient communication)			**Model 1.2** (PCP communication)			**Model 1.3** (Model 1.2 + patient control)			**Model 1.4** (Model 1.3 + PCP control)			**Model 1.5** (Model 1.3 + PCP training)		
Fixed effects		*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*
Level 1 (*n* = 218)																
Patient communication (RIAS)																
Information provision		1.01	0.99, 1.02	>0.05												
Question asking		0.99	0.90, 1.08	>0.05												
Activation		1.01	0.93, 1.09	>0.05												
Responsiveness and emotion		1.01	0.99, 1.03	>0.05												
PCP communication (RIAS)																
Education and counselling					1.00	0.99, 1.02	>0.05									
Question asking					1.01	0.97, 1.05	>0.05									
Partnership building and activating					1.02	1.00, 1.05	<0.05*	1.03	1.01, 1.05	<0.001*	1.04	1.02, 1.06	<0.001*	1.04	1.02, 1.06	<0.001*
Responsiveness and emotion					1.01	0.99, 1.03	>0.05									
Procedural					1.00	0.97, 1.04	>0.05									
Level 1 controls																
Consultation duration		0.99	0.99, 1.00	>0.05	0.99	0.99, 1.00	>.05									
Patient BMI								1.09	1.03,1.16	<0.01*	1.08	1.02, 1.15	<0.01*	1.08	1.02, 1.15	<0.01*
Patient gender (ref: female)								1.04	0.52, 2.08	>0.05						
Patient, unemployed (ref: employed/retired)								0.19	0.04, 0.79	<0.05*	0.21	0.05, 0.82	<0.05*	0.19	0.04, 0.78	<0.05*
Patient, high school or lower (ref: college/university)								0.56	0.27, 1.18	>0.05						
Level 2 (*n* = 14)																
Level 2 controls																
PCP Gender (ref: male)											1.77	0.79, 3.97	>0.05			
PCP time in practice (months)											1.00	0.99, 1.00	>0.05			
PCP BMI											1.04	0.84, 1.29	>0.05			
PCP training (ref: no training)																
Nutrition														0.63	0.26, 1.50	>0.05
Obesity														1.40	0.24, 8.17	>0.05
Behaviour change														1.53	0.59, 3.94	>0.05
Physical activity														1.63	0.62, 4.26	>0.05
Random effects																
Level 2 variance (95% CI)	0.11 (0.01, 2.56)	0.08 (0, 8.67)			Not calculable			0.10 (0, 6.79)			Not calculable			Not calculable		
Level 2 ICC[a]	3.36%	2.5%			Not calculable			3.0%			Not calculable			Not calculable		
Log likelihood	-121.72	-114.78			-114.03			-107.74			-107.50			-106.98		
LR^1 test	χ^2 (1) = 0.63, *p* = 0.21	χ^2 (1) = 0.25, *p* = 0.30			χ^2 (1) = 0, *p* = 1			χ^2 (1) = 0.30, *p* = 0.29			χ^2 (1) = 0, *p* = 1			χ^2 (1) = 0, *p* = 1		
LR^2 test	n/a	χ^2 (5) = 12.83, *p* = 0.02*			χ^2 (6) = 0, *p* = 1			χ^2 (5) = 22.0, *p* = <0.001*			χ^2 (6) = 22.27, *p* <0.01*			χ^2 (7) = 23.94, *p* = 0.001*		
LR^3 test	n/a	n/a			n/a			χ^2 (1) = 0, *p* >0.05			χ^2 (1) = 0.47, *p* >0.05			χ^2 (1) = 1.06, *p* >0.05		

[a] Inter-class correlations indicating the proportion of total variance explained by between PCP differences; * Statistically significant; LR^1 = Likelihood ratio test comparing multilevel model to standard logistic regression model; LR^2 = Likelihood ratio test for model improvement over null model; LR^3 = Likelihood ratio test for model improvement over previous model

Table 3: Two-level logistic regression model with binary outcome variable, weight-related consultation outcome (0 = no, 1 = yes)

	Model 2.0 (Null model)	**Model 2.1** (patient communication during weight discussion)			**Model 2.2** (PCP communication during weight discussion)			**Model 2.3** (patient controls)			**Model 2.4** (PCP controls)		
Fixed effects		OR	*95% CI*	*p*	OR	*95% CI*	*p*	OR	*95% CI*	*p*	*OR*	*95% CI*	*P*
Level 1 (*n* = 54)													
Patient communication (RIAS)													
Information provision		0.99	0.74, 1.31	>0.05									
Activation		0.93	0.29, 2.94	>0.05									
Responsiveness and emotion		1.23	0.81, 1.87	>0.05									
PCP communication (RIAS)													
Education and counselling					0.82	0.55, 1.23	>0.05						
Partnering and activating					0.37	0.10, 1.34	>0.05						
Responsiveness and emotion					0.88	0.47, 1.65	>0.05						
Procedural					0.54	0.19, 1.57	>0.05						
Level 1 controls													
Weight discussion duration		1.02	0.94, 1.11	>0.05	1.18	0.97, 1.44	>0.05						
Number of weight discussions								2.74	1.14, 6.57	<0.05*	4.27	1.57, 11.59	<0.05*
Patient BMI								1.15	1.00, 1.33	<0.05*	1.13	1.01, 1.25	<0.05*
Patient gender (ref: female)								1.45	0.24, 8.64	>0.05			
Education, high school or lower (ref: college/university)								0.62	0.05, 7.08	>0.05			
Level 2 (*n* = 13)													
Level 2 controls													
PCP gender (ref: male)											0.01	0, 0.83	<0.05*
PCP time in practice (months)											0.98	0.97, 1.00	0.05*
PCP BMI											0.61	0.18, 2.11	>0.05
Random effects													
Level 2 variance (95% CI)	1.23 (0.13, 10.83)	2.42 (0.08, 69.74)			3.21 (0.16, 62.63)			1.39 (0.06, 30.16)			Not calculable		
Level 2 ICC[a]	27.23%	42.46%			49.44%			29.70%			Not calculable		
Log likelihood	-29.61	-15.79			-14.24			-21, 70			-16.71		
LR[1] test	χ^2 (1) = 2.57, *p* = 0.05*	χ^2 (1) = 1.53, *p* >0.05			χ^2 (1) = 2.47, *p* = 0.05*			χ^2 (1) = 1.39, *p* >0.05			χ^2 (1) = 0, *p* >0.05		
LR[2] test	n/a	χ^2 (4) = 7.85, *p* >0.05			χ^2 (5) = 5.58, *p* >0.05			χ^2 (4) = 8.11, *p* >0.05			χ^2 (5) = 11.54, *p* <0.05*		
LR[3] test	n/a	n/a			n/a			χ^2 (1) = 14,92, *p* <0.001*			χ^2 (1) = 9.98, *p* =0.001*		

[a]Inter-class correlations indicating the proportion of total variance explained by between PCP differences; * statistically significant; LR[1] = Likelihood ratio test comparing multilevel model to standard logistic regression model; LR[2] = Likelihood ratio test for model improvement over null model; LR[3] = Likelihood ratio test for model improvement over previous model