Research Article

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Personalized Medicine

Genomics-informed weight management in primary care: anticipated public interest

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Aim: An exploratory survey assessed the influence of current and potential future genomic applications for weight management on individuals' desires to address weight management within primary care. **Materials & methods:** A convenience sample of 714 US adults aged 18–70 completed an online survey that presented three scenarios: no genomic information; current genomic capabilities; and potential future applications of genomics for weight management. **Results:** Participants had increased interest in weight management assistance through primary care when considering genomic applications in weight management, $p(1,1.68) = 24.66$, $p < 0.001$; this increase was more robust among individuals who felt their weight was important for their health, $p(1,1.68) = 20.85$, $p < 0.001$. **Conclusion:** Primary care systems may need to accommodate a rise in the volume of patients seeking weight management assistance as genomic approaches come to fruition.

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Keywords: genomics • precision medicine • primary care • weight management

Over two-thirds of American adults meet criteria for being overweight or obese [1], making it one of the leading public health issues of our time. Despite clinical recommendations from the US Preventive Services Task Force [2], and economic incentives created by the Affordable Care Act [3], weight management continues to be underaddressed in primary care settings. Both provider- and patient-specific barriers remain that prevent the effective delivery of weight management interventions within primary care. Provider barriers most commonly cited include shortages of clinicians, lack of training or confidence in delivering weight interventions, and operational issues in busy care settings [4–6]. Feelings of frustration or fatalism among physicians with respect to patients' ability to change also contribute [7,8]. Additional barriers include the widespread perception that weight is a personal rather than medical issue [9], and therefore should not be addressed in the medical setting. Patients with overweight and obesity also commonly report feeling stigmatized by providers with respect to their weight [10], leading to avoidance or delay in seeking healthcare [11,12]. Consequently, rates of discussing weight and obesity in primary care remain low [13].

At the same time, scientific advances in genomics have the potential to bring about important changes [14] that may alter the manner in which care is delivered [15]. Experts have argued that genomic applications are likely to extend to the prevention and management of common, complex conditions [16,17], including weight and obesity [15] both inside and outside the clinic [18–20]. There is hope that provision of genomic information relevant to weight management and obesity may overcome some of the aforementioned attitudinal barriers to delivery of weight management intervention in primary care. For example, continued progress in genomic discoveries may medicalize weight in the minds of patients, thereby driving an increase in primary care weight management discussions [21]. Additionally, genomics-oriented weight discussions can have the added benefit of reducing perceived stigmatization [22], which can keep patients from seeking care in the first place [11,12]. For these and other reasons, genomic integration has the capacity to increase rates of weight intervention in primary care.

Even a small uptick in weight discussion in primary care settings can be a boon for patient health [23]. However, without compensatory resource allocation, such increases run the risk of overwhelming an already-overburdened primary care system. Thus, data that would allow us to understand whether genomic advancements in precision weight management are likely to increase patient demand for primary care weight management could aid in future

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resource allocation planning. Moreover, it is imperative that we try to anticipate the effects of precision medicine now, before it is realized. Once these technologies enter the market and are made available for healthcare integration, it may be too late to adequately prepare.

With that overarching objective, we conducted the present exploratory survey to assess the influence of current and potential future genetic and genomic capabilities on patient intentions to discuss weight management with their primary care provider (PCP). Our research questions evaluated:

- Whether individuals report increased intention to seek weight management advice from their PCPs, when asked to consider how genomic factors, both current and future, could be incorporated into weight management.
- Which patients would most likely increase their utilization of PCPs for genome-based weight management approaches.

Materials & methods

Participants

A total of 896 individuals responded anonymously to an online survey conducted in 2014–2015. All participants gave informed consent to participate in this study. Participants were recruited through a genetics exhibit at the Smithsonian Institution Museum of Natural History in Washington, D.C., as well as through online recruitment postings and advertisements for a group of surveys under the heading 'Social Genomics Project' on exhibit-related websites and on Facebook. Data were analyzed in 2016. Individuals were included in analyses if they were at least 18 years of age. Given the country-specific nature of healthcare, only those who reported residing in the USA were included (52 respondents excluded). We restricted our analysis to individuals <70 years old, as weight management advice changes at older ages [24,25] (75 respondents excluded). We also excluded those who reported intentions to gain weight (35 respondents), as their weight management efforts were different from most US adults [26]. Finally, individuals whose self-reported weight and height were highly unlikely were excluded (BMI > 60 or 3 standard deviations outside the distribution, 15 respondents). A total of 714 individuals were included in the final sample. This study was ruled IRB exempt by the National Institutes of Health Office of Human Subjects Research Protections.

Study variables

Intentions to utilize primary care for weight management

The primary outcome was assessed with a single item ('How much do you look to your PCP for help with your weight?'; 1–7 scale, 'not at all' to 'very much') [27], repeated under three different scenarios (see Table 1). Scenario 1 referred to the present, wherein no genomics content was salient (No genomics). In scenario 2 (Current genomics), participants were told that genetic susceptibility testing can currently inform individuals of slight increases to their risk of being overweight. Scenario 3 (Future genomics) was hypothetical, and speculated that future advancements in genomics may yield more precise risk assessments and allow for precision weight management programs.

Weight importance

The extent to which participants value a 'healthy weight' was assessed with a single item, 'How important is it to you to have a healthy weight?' This was measured using a 1–7 scale, where 1 = 'not at all' and 7 = 'very much'. This item was created for the current study and is not validated.

Weight goals

Participants indicated their current weight goal with a single, multiple-choice item, with possible responses as: trying to lose weight; trying to keep off weight already lost; actively trying to not gain weight; trying to gain weight, or; 'I don't think about my weight'. Due to conceptual similarity in this context, trying to keep lost weight off and actively trying to not gain weight were collapsed into one category for analysis. Those indicating a goal to gain weight were excluded. This item was created for the current study and is not validated.

Perceived weight status

Participants classified their current weight as 'underweight', 'about right', 'overweight', or 'very overweight' [28]. During analysis, 'underweight' and 'about right' were collapsed into a single category which we report here as 'lean'.

Table 1. Demographic and descriptive statistics (n = 714).

Demographics & participant characteristics	Counts (%) or means (SD)
Race	
White	577 (80.8%)
Black	64 (9.0%)
Native Hawaiian or other Pacific Islander	1 (0.1%)
Asian	13 (1.8%)
Indian or Alaska native	7 (1%)
More than one race	36 (5.0%)
Unknown	16 (2.2%)
Ethnicity: Hispanic/Latino	46 (6.4%)
Gender: Female	592 (82.9%)
Has regular primary care provider	606 (84.9%)
Education	
College graduate	264 (36.9%)
Some college/technical degree	296 (41.4%)
High school or equivalent	119 (16.7%)
Less than high school	35 (5.0%)
Recruited online	670 (93.8%)
Age in years	40.4 (SD = 18)
Body mass index	29.13 (SD = 7.79)
Weight goal*	
Lose weight	379 (53.1%)
Maintain weight	218 (30.5%)
Do not think about weight	115 (16.1%)
Perceived weight status	
Lean†	217 (30.4%)
Overweight	323 (45.2%)
Very overweight	174 (24.4%)
Personal weight importance‡	5.98 (SD = 1.79)
Outcome variables	
Look to provider (no genomics)‡	2.58 (SD = 1.71)
'During this survey, please think of "your primary care provider" as the healthcare professional you see to take care of your overall health. This would be the person you would go to for medical checkups when you are well... How much do you look to your primary care provider for help with your weight?'	
Look to provider (current genomics)‡	3.48 (SD = 1.86)
'There are genetic factors that influence people's weight. Right now, it is possible to find out if someone has a slightly higher risk of being overweight (e.g., gaining an extra 3–7 pounds) by testing whether or not they have certain versions of a gene.... How much would you look to your primary care provider for help with your weight?'	
Look to provider (future genomics)‡	3.73 (SD = 1.92)
'In the future, it could be possible to look at someone's entire genome to predict much more of their risk for being overweight. It might also be possible to create a personalized diet and exercise program based on someone's genes. This could make it easier for people to lose weight or to maintain a healthy weight....If this were possible, how much would you look to your primary care provider for help with your weight?'	

†Includes self-perceptions of underweight and 'about right'.
‡Outcome on a 1–7 scale.
*Two missing cases.
SD: Standard deviation.

We include perceived weight status as opposed weight category based on reported BMI due to the tighter connection between one's self-perception of weight and behavior (e.g., dieting). Prior research has found that individuals' perceived weight status is a more useful explanatory construct for weight-relation intentions and behavior. For example, Yaemsiri and colleagues [29] found that one's perceived overweight status was the most powerful predictor of dieting behavior in a large national sample. Indeed, individuals often misperceive their weight status. It is therefore believed that experienced weight status as opposed to one's actual weight status that is more

relevant to cognition and behavior. For this reason, we opted to use perceived weight status as the explanatory construct. Perceived weight status category was correlated with self-reported BMI $r = 0.32$, $p < 0.0001$.

Demographics & recruitment method

Participants reported their age, gender, race/ethnicity, education level, perceived health status and whether they had a PCP. Perceived health status was assessed with a five-point scale (1 = 'poor' and 5 = 'excellent'); BMI was computed from participants' self-reported height and weight (k/m^2). Participants answered 'yes' or 'no' to the question, 'do you have a primary healthcare provider'. Recruitment source was categorized as either 'museum' or 'online' depending upon whether they completed the survey during, versus following, the tenure of the museum exhibit.

Statistical analysis

Data were analyzed using SPSS version 19 (NY, USA). Descriptive statistics were calculated for all variables with means (standard deviation) for continuous variables, and counts (percent) for categorical variables. Research question one was addressed using the first step in a two-step Repeated Measures Analysis of Covariance (ANCOVA), where step one includes only the main effect of scenario and covariates, and step two (addressing research question two) adds key predictor variables (weight importance, weight goals and perceived weight status) into the model. Covariates included race, college education, age, gender, having a regular healthcare provider and recruitment method. Statistical significance was assessed at $p < 0.05$.

Results

Descriptive statistics

The majority of participants were recruited online and reported that they were white, were females, and that they had a regular PCP. A little over a third reported that they had a college degree. Table 1 displays these descriptive statistics and those of the outcome variable for all three genomics scenarios.

Research question one: change in weight advice seeking

Analysis of changes in participants' indicated interest in looking to their PCP across scenarios can be found in Table 2. In the first step, there was a statistically significant effect of considering genomics on the extent to which participants anticipated looking to their PCP, $p (1.62, 1154) = 24.66$; $p < 0.0001$. *Post hoc* tests were conducted using Bonferroni adjustments and revealed a significant increase between no genomic considerations and the current genomic climate ($M = 2.58$, $SD = 1.71$, $M = 3.49$, $SD = 1.90$); $p < 0.0001$, and a significant increase between current and future genomic integration ($M = 3.74$, $SD = 1.91$); $p < 0.0001$, (Figure 1).

Research question two: moderators of change in weight advice seeking

In the second step, the repeated-measures ANCOVA was adjusted such that key predictor variables were included in the model (Table 2). There was no longer a significant main effect of genomic considerations on reported interest in looking to one's PCP, $F(1.68, 1163) = 0.96$; $p = 0.383$. However, there was a significant interaction effect of the extent to which participants consider weight to be important and genomic scenario, $F(1.68, 1163) = 20.85$; $p < 0.0001$. Higher value placed on weight increased the extent to which considering genomic integration into weight management was related to higher participant interest in looking to their PCP for weight advice (Figure 1). There were also significant interaction effects between level of genomic consideration and age $p (1.68, 1163) = 6.84$; $p < 0.0001$, and education $p (1.68, 1163) = 5.19$; $p < 0.0001$.

Discussion

This exploratory report demonstrates that patients have increased interest in utilizing PCPs for weight management when they consider the promise of genomic information. While interest increased overall, it is important to note that mean levels of reported interest were in the 'somewhat interested' range, rather than indicating overwhelming desire. As others have noted [30,31], this suggests that there is unlikely to be the 'tsunami' of increased care utilization predicted in early reports on genomic translation [32]. Still, our results suggest that if genomics for weight management becomes widely available, internal medicine clinics and primary care systems may need to prepare to accommodate a rise in the volume of patients seeking weight management assistance. This is especially important given that PCPs feel ill-equipped, both to provide quality weight care [8] and to interpret and use genetic and

Table 2. Predictors of change in interest of looking to primary care provider for weight management across genomic levels; repeated measures ANCOVA.

Steps	Mean square	df	F
Step one			
Level of genomics	29.62	1.66	24.66†
Level of genomics x race (ref = white)	0.21	1.66	0.14
Level of genomics x college graduate	8.17	1.66	5.65†
Level of genomics x age	9.94	1.66	6.87†
Level of genomics x gender (ref = male)	2.95	1.66	2.04
Level of genomics x regular provider (ref = yes)	3.93	1.66	2.72
Level of genomics x recruitment method	4.56	1.66	3.13
Error	1.44	1158.52	
Step two			
Level of genomics	1.33	1.68	0.96
Level of genomics x personal weight importance	28.97	1.68	20.85†
Level of genomics x weight goal (ref = lose)			
Maintain weight	0.54	1.68	0.36
No weight goal	0.61	1.68	0.44
Level of genomics x weight status (ref = lean)			
Overweight	1.73	1.68	1.25
Very overweight	3.04	1.68	2.19
Level of genomics x has regular PCP	3.88	1.68	2.79
Level of genomics x gender (ref = male)	1.61	1.68	1.16
Level of genomics x age	9.50	1.68	6.84†
Level of genomics x race (ref = white)	1.15	1.68	0.42
Level of genomics x college graduate	7.21	1.68	5.19†
Level of genomics x recruitment method	2.46	1.68	0.13
Error	1.34	1163.90	

†$p < 0.01$
ANCOVA: Repeated measures analysis of covariance; df: degrees of freedom; F: statistic reported in the ANCOVA.

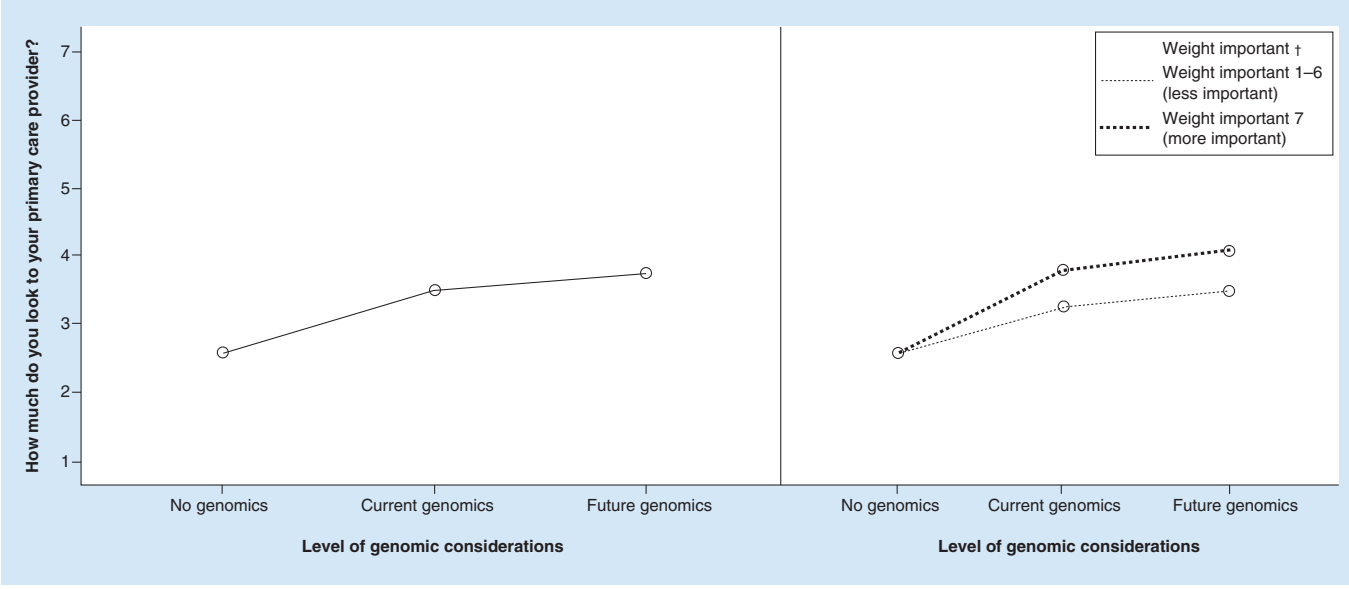

Figure 1. Effect of genomic scenarios on intention to look to primary care provider for weight management, and moderating effect of perceived weight importance.
†Weight important is a continuous variable in analyses, but is dichotomized for graphical purposes here.

genomic information in clinical practice [33]. Although efforts are in progress to increase education and training in both domains [34,35] [36], such programs may need to fill a widening gap in the future.

To improve readiness to serve an increasing patient population seeking clinical weight management services in the genomic era, it will be important to more precisely determine as to which segments are likely to drive this demand. Our findings demonstrate that increases were strongest among individuals who considered having a 'healthy weight' to be important. Indeed, this accounts for almost all of the variability in intentions to utilize PCPs. However, this attitudinal information is not likely to exist in patient records, and is thus unknown for most patients in health systems. As such, healthcare providers and systems may benefit from paying greater attention to patient attitudes and beliefs in this domain. In addition, this finding is consistent with the notion that one's level of concern about a health condition can be an important driver of genetic testing interest, in addition to, or even over and above, one's affected or risk status [37,38].

Limitations

The current study has several limitations. The survey was administered to a convenience sample of individuals who are relatively homogeneous on some characteristics, and due to recruitment methods, are likely more thoughtful about body weight and more interested in genomics than the general population. This substantially limits generalizability of study results. However, we attempted to address this by exploring relationships between personal or demographic characteristics and attitude changes. In addition, the current survey was not pilot tested and validated prior to fielding. Participants were exposed to multiple genomics scenarios and may have increased their ratings to each successive scenario in response. However, there was a much larger jump between the first and second scenarios than the second and third scenarios, which argues against this interpretation. In addition, several of the constructs were assessed with short- or single-item measures as is typical of large surveys. Given the anonymous nature of the survey, we are unable to definitively determine the recruitment source of any individual participant, and therefore had to infer recruitment method based on the time-frame of survey completion. Thus, a response rate cannot be determined. This was a cross-sectional analysis, which precludes us from inferring causal relationships. Finally, one of the scenarios provided in the survey discussed a hypothetical future state of medicine that does not currently exist and may differ from eventual deployment patterns.

Conclusion

Our results, if confirmed, have future implications regarding the ramifications of genomic integration in primary care weight management. First, the potential uptick in primary care utilization may require structural changes in how obesity care is delivered. Second, increasing efforts to train PCPs and their teams will be needed to boost confidence in addressing weight management, genetics, and genomics. Third, interventions that leverage primary care for tailoring weight management are needed to capitalize on genomic discovery and patient interest. In all, the findings from the current study show the potential promise of genomic development for addressing public health issues related to overweight and obesity, and also highlight the workforce capacity we will need to build to get there.

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Ethical disclosure

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

Authors' contributions

The study was conceived and designed by S Persky; data analysis and interpretation were performed by S Persky, MR Goldring and RW Cohen; paper drafting and revision were done by S Persky, MR Goldring and RW Cohen; approval of final version was obtained by S Persky, MR Goldring and RW Cohen; and accountability for work lies with S Persky, MR Goldring and RW Cohen.

Summary points

- Experts have argued that genomic applications may extend to prevention and management of common complex conditions like obesity.
- Provision of genomic information relevant to weight management and obesity may lead to an uptick in patient demand for primary care weight management services.
- Increased use of primary care for weight management could help address the current high rates of obesity.
- Data that would allow us to understand whether genomic advancements in precision weight management would increase patient demand for primary care weight management could aid in future resource allocation planning. Indeed, it is crucial to anticipate the effects of precision medicine before it is realized.
- This exploratory report demonstrates that patients have increased interest in utilizing primary care providers for weight management when they consider the promise of genomic information.
- While interest increased overall, mean levels of reported interest were in the 'somewhat interested' range, rather than indicating overwhelming desire.
- Increases in interest were strongest among individuals who considered having a 'healthy weight' to be important. However, this attitudinal information is not likely to exist in patient medical records.
- In all, the findings from the current study show the potential promise of genomic development for addressing public health issues related to overweight and obesity, and highlight the workforce capacity we will need to build to get there.

Financial & competing interests disclosure

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