Brenda Davy, PhD
Dietary Assessement Methods in Nutrition Research

SIGMA NUTRITION RADIO

Episode 263

Danny Lennon: Here we are. Brenda thank you for joining me on the podcast today, it's an absolute pleasure to have you here.

Brenda Davy: Sure. Thank you for inviting me.

Danny Lennon: We have quite a lot to discuss and I definitely have some questions that I'm interested to ask you. Before we get into any of that good stuff maybe a good place to start would be to give people an idea of your own background, and specifically your academic career to-date and how that's led you into some of your current work?

Brenda Davy: Sure. Well, I've received an undergraduate degree in Dietetics and Nutrition, and then a Master's degree in Exercise Physiology from Virginia Tech, and then I worked as a research dietician at the Center for Human Nutrition in Denver, Colorado for about five years before deciding to go back and get my Ph.D. and then I pursued a Ph.D. at Colorado State University and that degree was in Human Nutrition. I finished that in 2001 and eventually ended up back here at Virginia Tech and I'm current a professor in the Department of Human Nutrition, Foods, and Exercise. My research program is focused on really two major areas. The first is developing interventions to prevent or treat obesity or type-2 diabetes. The second area is dietary assessment, so I'm interested in developing methods to better assess dietary intake using self-reported methods, and also validate dietary biomarkers.

Danny Lennon: I definitely want to dig quite a bit into that because I definitely know it's been an issue and a challenge for many of the people listening who like to dig into the research and look for the evidence to point them in the right direction towards making decisions for themselves and the people they work with. One of the huge things as you mentioned can be dietary assessment that sometimes gets overlooked and sometimes there are nuance that maybe not be quite understood, and I think you are in a particularly good position to hopefully give some insights in this particular area. So, maybe a best place to start would be take us through maybe some of the more conventional and typical measures that have been used in the past from an overview level, and then maybe we can get into each one of those a bit more specifically then?

Brenda Davy: Right. So, the three most commonly used methods for evaluating dietary intake as far as self-reported methods go would be food records, dietary recalls or 24-hour recalls or food frequency questionnaires. They are used and it may depend on issues like staffing or study resources or funding that the decision as to which may be used may depend on those sorts of factors. But food records are usually kept for three or four consecutive days where study participants will record all of their food and beverage intake. Twenty-four hour dietary recalls are another method and those were obtain on three to four non-consecutive days within a one or two-week timeframe, and usually an interviewer will obtain those either in-person or over the phone but there are also online recall methods that are now available. Lastly, food frequency questionnaires which can be self administered, so research participants can fill those out on their own and those provide information on the study participants' diet over longer timeframes so maybe over the past 30 days or maybe over the past 6 or 12 months.

Danny Lennon: Right. So, with any of those self-report measures as I think some people maybe guessing at this time point there are some clear advantages from a logistical perspective to using some, but there may be some disadvantages also. From your perspective – and maybe it differs between each of them, what are some of the main advantages and disadvantages of some of those methods?

Brenda Davy: Right. So, one of the advantage of the food records or diaries is that they are not as reliant on study participants' memories, so the idea here is that study participants' are recording everything

that they are eating or drinking as they go throughout the day. So, they are not having to remember what they had yesterday or the day before. So, that's a major advantage of food records. You also don't have to have a trained interviewer present over a number of days to obtain the information. So, a study participant could be instructed in the method to record their food intake, and then they could return that record in a couple of days and someone would review that record. So, that can be an advantage there. With the multiple 24-hour recalls those are generally thought to be the best method as far as self-reported methods go. So, that's a major advantage there. They are done spontaneously, so they are less likely to lead study participants to change their dietary intake habits because you're asking participants about what they did the day prior, so that's a major advantage there. The major advantages with food frequency questionnaires again is that you don't have to have a trained person there to administer that tool, and the other advantage is that you're capturing habitual intake over a longer period of time, so you're not just about asking about what the participant had over three or four days recently but over longer timeframes. The major advantage there is we're generally interested in long-term dietary habits and how those impact health outcomes.

Danny Lennon: Right. So, with that collection of ideas it's quite clear that whilst there are these different advantages there's always going to be a trade-off when we're making a decision between these, as you mentioned, to try and get a hopefully kind of meticulous record of what people have been eating but in a way that isn't too invasive. Asking them to keep a food diary for few days can be useful, but runs the risk of having them change their dietary habits because of that. So, then we can think of well dietary recall takes care of that because it's more spontaneous but that comes into the issue of people's memory for example, and then both of those methods probably used on this acute sense over a number of days, we can take care of that with the food frequency questionnaire. So, it almost seems like there's always this trade-off that we're getting at something from each one, but we're also then some other components, right?

Brenda Davy: Right. I think the key issue for researchers is to figure out what is the best method given their circumstances and given the purpose of their study to be able to justify which method they are going to use. Also, with all of these methods researchers will have to acknowledge the limitations of the self-reported methods in

general and that major limitation with all of these methods is the likelihood of participants underreporting their dietary intake.

Danny Lennon: Right. I think that's the main criticism that often gets leveled at self-reported methods is the misreporting and typically that tends to be underreporting when it comes to total energy intake. Do we know in general, and again I'm sure this changes from demographic to demographic or from study to study but there's any idea of just to what extent some of this underestimation or misreporting can be with some of these measures?

Brenda Davy: Right. So, in general I would say that it varies according to these demographics of the study population. We know that certain sub-groups are more prone to underreporting their dietary intake. For example, women are more prone to underreporting, and also individuals with obesity are more prone to underreporting energy intake. So, those are some common challenges for dietary assessment in those study populations. In general underreporting can range from as little as 0% to 3% of known energy intake or it could be as much a 50%.

Danny Lennon: Well, and so once people hear not only that wild range but also how high it could potentially get at least for individual data points can kind of throw up well we might not really know what this person is consuming at all, at least to any degree of accuracy. You mentioned that there are some particular types of demographics that can lead to a higher chance of misreporting. I am wondering are there also particular diet habits or particular types of meals that sort of thing that can cause more inaccurate reporting. Is there any commonalities or patterns that you see that tend to be a red flag for likelihood of misreporting?

Brenda Davy: Right. In general I would say there are two issues there. The first is that there is social desirability issues, so consumption of foods that are considered maybe sin foods are more likely to be underreported. So, that could be high sugar, high fat foods or it could be alcohol. Then there is also another issue and that is forgotten foods, so there are some foods or meals that are more likely to be forgotten and that might be snacks or things consumed between meals. It might be beverages or it might be condiments, and so it's both the social desirability issue as well as commonly forgotten foods.

Danny Lennon: So, essentially we have these both intentional and unintentional misreporting the intentional being related to social desirability, as you say, and the unintentional being things that people either forget or might be a bit more difficult to assess how much they've consumed?

Brenda Davy: Right, exactly.

Danny Lennon: Okay. Now that we know that this is such a clear problem presumably some of the developments of some of these self-report measures over the years have tried to account for this in some way. What sort of things have been done over time to try and like I said either account for this or mitigate the degree of underreporting we may see?

Brenda Davy: Right. So, this is a very important issue that when self-reported methods are criticized there is often not attention to this, and so as self-reported methods are so commonly used in nutrition research there are things that researchers can do to minimize these issues. The first issue is using trained staff to obtain recalls or review food records or food frequency questionnaires, and so that's important because trained staff may know how to probe for commonly forgotten foods and they also maybe more aware of this issue of socially undesirable foods, and so they may be able to problem for those things as well. You can also use validated protocols, and so the United States Department of Agriculture has studied this Automated Multiple Pass Method of obtaining dietary recalls. We refer to that as the AMPM method, and this is the method that's used in the U.S's large-scale ongoing nutrition surveillance called the NHANES survey. And so with this method, the AMPM method what the trained interviewers will do is they will go through a repeated cycle of asking participants about their pattern of food intake and they will probe for more detail about foods consumed in a very structured way and when using this AMPM method it has been shown to increase the accuracy of the self-reported methods, so that energy intake maybe as close as 3% to energy intake determined by doubly labeled water which is a gold standard for evaluating energy intake in folks.

Danny Lennon: Wow! That's actually pretty incredible to hear and I think that also has a lot of practical value I think even for many people listening here. We have quite a lot of dieticians, nutritionists, coaches who are working and practice with people and I am sure they'll be nodding along after hearing some of the limitations you

mentioned to some self-report measures and how some people can misreport, and I think it does take quite a long time to build up to the point where they are able to get more and more accurate feedback from clients who are doing this, and now hearing about there are some strategies out there to increase the ability to get that information from people and to drive more accuracy from that is pretty useful. And to see that was able to get that close is actually quite impressive. Now, that we've talked about some of the self-report measures and ways that they can be improved and limitations, cases where they may have value. I know you've talked quite a bit about some of the newer but also more in-depth ability to I suppose get deep in or get more accurate information. And so, there are probably a number of these we can touch on. Some of these probably relate to using biomarkers in the lab and there are probably different components of this that you've talked about before. So, again from an overview level what is kind of being the next step from self-report measures? Where is the level above that in terms of ability to get accurate data?

Brenda Davy: Right. There is a lot of interest in developing dietary biomarkers, which can objectively assess dietary intake. There are some dietary biomarkers that had been around for a long time like urinary nitrogen excretion which provides information on protein intake or doubly labeled water which is a method that can be used in free living circumstances to assess energy intake. So, there are dietary biomarkers, and then there are also technology based methods which are being developed to provide more objective information on dietary intake.

Danny Lennon: To touch on some of those biomarkers specifically you mentioned one is being nitrogen excretion, presumably that being a urine test. What other kind of things can be measured and what type of things tell us about diet, where is the scope of things like measuring excretion of certain markers?

Brenda Davy: So, probably the most well studied dietary biomarkers would include urinary nitrogen which indicates protein intake, and then urinary sodium excretion which would provide a good indication of dietary sodium intake. So, those have been around for a long time and there has been a lot of research to support their validity. There are some newer ones; urinary sugars have been studied as an indicator of dietary sugar intake. There is less validation work that's been done there and there are some limitations to that

method, but it is available and it has been used in research studies. There are also some biomarkers of individual foods or nutrients such as whole grains or wine or nuts or olive oil or caffeine. In general there is just a lot less information available about their validity and reliability and sensitivity to detect changes in dietary intake.

Danny Lennon: Right, and presumably going into the future it's going to be more a case of when these are use of them being each pieces in a puzzle as they are giving us data on individual nutrients as opposed to an overview of the whole diet. One thing that might tie into that is you mentioned previously the gold standard we have for looking at typically energy expenditure for example, doubly labeled water. Can you maybe touch on that method specifically, give people an insight as to what exactly it is, and then again some of the value that that can have within research and potentially then some of the downsides?

Brenda Davy: Right. The doubly labeled water method has been around for a long time. It's been very, very well studied, and with this method study participants are dosed with two isotopes deuterium and O18. So, they are provided with this labeled water which contains these two isotopes and they consume that water, and then urine samples are taken by researchers over a one to two week period and the elimination rates of those isotopes are then mathematically related to that person's energy expenditure or energy requirements if they are weight stable. So, provides information on energy intake in an objective free living way.

Danny Lennon: Are there any other similar methods that are either not as well known as doubly labeled water that also work in a similar fashion or that would be in the same kind of class of method but maybe people listening haven't heard of as much?

Brenda Davy: Right. There is a lot of interest in stable isotope ratios as biomarkers or potential biomarkers of dietary intake, and so this is a newer area of biomarker research. But there are these naturally occurring stable isotopes of carbon, nitrogen, and sulfur that have been proposed as biomarkers of sugar, meat, and fish intake respectively. The idea here is that they are different forms of the same element which differ in the atomic mass, and so you might evaluate these stable isotope ratios in different biological sample types like urine or blood or hair and that might provide information on intake of sugars or meats or fish.

Danny Lennon:	One thing that I know you've talked about in the past before has been kind of one of the areas you've discussed has been around metabolomics. Can you maybe touch on exactly what that is and how that relates to some of this discussion?
Brenda Davy:	Right. This is another newer area of dietary biomarker research. The idea with metabolomics is that there are metabolites of foods or food components that could be tested in urine or blood that might provide information on intake of a food or even of a dietary pattern such as the dash-diet or the Mediterranean diet.
Danny Lennon:	Super interesting and with that where do you see the potential for use of such methods. Where are the main I supposed opportunities for this to be a positive thing and what are some of the limitations with some of this stuff right now?
Brenda Davy:	Right. One of the real advantages of the metabolomics approach is that it does provide information on or it could provide information on overall dietary patterns or the overall quality of an individual's dietary intake. In the nutrition research world that's really where we're sort of evolving toward as one of our major areas of interest, not just intake of a particular food or nutrient but somebody's overall dietary quality, and so that's where metabolomics may represent a real advantage is that we may be able to provide objective information on someone's overall dietary quality or dietary pattern using this type of approach. The disadvantages there is that first it's a really new area of biomarker research, so there is not a lot of research that has been done which has evaluated validity and reliability and also sensitivity to change of metabolomics based biomarkers. There are also issues related to cost, and equipment, and feasibility. So, we probably have a long way to go before these are used really widely in nutrition research. We do still need a lot of research using controlled feeding designs to provide the best indications of biomarker validity using this and other approaches.
Danny Lennon:	Right. If some of those challenges can be overcome I think that it seems extremely exciting given like you say we can move towards this overview of the diet as opposed to away from specific nutrients which from a practical recommendation perspective is kind of the center of the bull's eye for us of trying to get down to some food-based recommendations for people as opposed to talking in nutrients all the time in isolation, so certainly exciting. I

do want to get to the tech-based methods that you previously alluded to. I know people can probably assume that we can talk about some of these in the form of wearable devices that they no doubt own or at least have seen. Maybe we can touch on that, but also where is the scope, what else does this extend to when we can think about how technology can be used to assess diet?

Brenda Davy: Right. Related to the tech-based methods there are a couple of methods that have been pretty well studied in nutrition research using digital images, digital image-based methods. So, the idea here is individuals would take pictures of their foods or meals using a smart phone, and then that information would be sent to the researchers who could evaluate both the type and quantity of food and use that as sort of an automate mobile dietary record type of approach. So, the two systems that had been very, very well studied include the remote food photography method which Dr. Corby Martin at the Pennington Biomedical Research Center in Baton Rouge, Louisiana has studied. Then the technology assisted dietary assessment method or TADA system that was developed by Dr. Carol Boushey at Purdue and University of Hawaii, and so there is a lot of research that's investigated those two digital image-based approaches. They differ a little bit. The TADA method is more fully automated in that the computer system is able to recognize the food, and also quantify the portion size reasonably well. That I guess, and I am not an expert in technology but I guess it's the estimation of portion size and food recognition that's represented a big challenge to the computer scientists who have developed this approach.

Danny Lennon: Yeah. That's the first thing that shot to my mind is the ability for something completely automated to accurately assess portion size. It'll be interesting to see how that develops and what degree of accuracy they can get to that, but presumably with all kind of machine learning the more and more input they're getting from more and more images over time that should hopefully increase the accuracy itself, even if the first part of it needs to be manually matching some of the output I guess.

Brenda Davy: Right. There is a lot of research going on to investigate that very issue.

Danny Lennon: Super interesting and I think that could – especially given the ability to use that and just how easy that is for someone to adopt. It's not really a new behavior for most people to be able to take

out a smart phone and take a quick photo, so that's an exciting area if they can get the accuracy down?

Brenda Davy: Right. It has been – study participants do like this approach as compared to the manual recording of the foods that they are eating. So, they have evaluated methods and users do then to prefer that digital image-based approach.

Danny Lennon: Yeah. I think even the short few seconds to start typing foods and trying to search for them and pull stuff up and having to know weights of things. Those things are all big enough barriers that I think that stop most people adopting it. So, if this can take off that's pretty amazing. Outside of food imaging is there other areas within technology that you think are ground for optimism going into the future?

Brenda Davy: Right. There are a few other methods that have been developed and are still being evaluated, and these are different type of body sensors and they can range from things like devices that are worn on the wrist and arm which might keep track of eating movement, and so that's a bit of technology that's being developed. It wouldn't provide information on the type or the quality of food consumed but it would measure bites and there has been a research demonstrating a correlation between bites and energy intake, and so that's one approach. There are also ears or chewing sensors that have been developed, and so individuals might have the sensor on their ear and it might be able to detect chewing movement again if that was paired with a camera it could take images of the foods, and then transmit that information to investigators. So, those are two of the newer methods that have been developed and there is a lot of research going on in this area. One of the big questions though with all of these tech-based methods is we don't know if there is reactivity that's taking place. In other words, when folks are taking pictures of their food or their wearing these sensors we don't know if that in and of itself will alter an individual's habits, and it's possible that it would. So, even though there is a lot of excitement around these tech-based methods there is still a lot of research that needs to be done to figure out how folks react to wearing these devices or to taking pictures of their foods.

Danny Lennon: And so, from even outside of a tech-based perspective it could be to do with anything that we're trying to advance in terms of improving dietary assessment into the future. Are there any other

areas or cases that you're most particularly interested in seeing how they pan out or other options available for continually trying to improve some of these measures going forward?

Brenda Davy: Well, I think there is even more great potential with these tech-based methods, I mean, if you think about how physical activity monitoring has changed so much in the past 10 years that now these devices that we put on our wrist have become very, very common. So, it may be that with the development of some of these wearables they can eventually become a form that wouldn't be intrusive and wouldn't interfere with our day-to-day activities such that we just sort of forget about them, get used to wearing them, and they can provide information on our dietary habits like is being done now with the physical activity monitors.

Danny Lennon: Yeah. It's certainly exciting time and kind of be interesting to see where some of this ends up over the next few years. Brenda before I start wrapping up here just to give some takeaway points for some people listening. One question I'd like to ask is in relation to anyone who tends to read any sort of nutritional science research and wants to keep an eye out for some of the dietary assessments that are used in various studies. How would you advice them of what sort of things to look for when they are reading through the methodology, what sort of things to be aware of, and any way they should frame some of these things in their own mind?

Brenda Davy: Probably most obvious issue that most folks will be aware of is that the major limitation of all self-reported methods is that the possibility of underreporting, and so that's very commonly acknowledge by researchers and it's a common criticism of nutrition research but that's always something that we need to keep in mind when we're reading nutrition research is that we're relying on self-report and that there are limitations there. But there are things that can be done by the researchers to improve the quality of their self-reported dietary intake data, and so I think that using the validated protocols such as that AMPM protocol that I mentioned earlier is one method that researchers can use to improve the quality of their self-reported methods. Also, making sure that they have as part of their research team individuals who have dietary assessment expertise so that they can help to make sure that quality control procedures are in place, that food records or recalls are being reviewed for quality and accuracy, that they are being analyzed by quality nutrition

analysis software that's another issue. So, all of these things are things that can be considerations when looking at nutrition research that involves dietary assessment, and then just considering the values that are reported for outcomes like energy intake in relation to what we think they should be given the study population. If we're studying a group of very active athletes and they are reporting that their dietary intake is 1200 calories a day then right there that's a pretty obvious red flag that a reader would know there's a problem there when you know that probably calorie requirements are 3,000 or 4,000 calories for that study population. So, I think using some of those common sense thought processes as well can be helpful.

Danny Lennon: And as we continue to get more of advancements with these biomarkers and the cost of using them comes down, and research the accuracy tends to improve we get more tech being brought in do you think we're going to be more and more moving to a place where self-report just falls away and we don't use it anymore and these things are going to replace it or how do you see that process playing out?

Brenda Davy: Right. That's a really good question. I think that it's important to remember that these developments are all very exciting. There is still probably many, many years down the road before there has been enough validation work to widely implement these in nutrition research. So, self-report is probably going to continue to be our primary method of evaluating dietary intake in nutrition research for the near future. But what can be done is when possible objective indicators of dietary intake such as these biomarkers can be included in research to complement or to support the dietary intake data that's self-reported. For example, if I'm interesting in studying added sugar intake then I might use self-reported methods to evaluate dietary sugar intake, but I might also include dietary biomarker which could support the self-reported information and give researchers a little more – allow them to have a little more faith in the accuracy of their self-reported methods.

Danny Lennon: Right, really good point. I'm glad you mentioned that. Before I get to the very final question Brenda if for people listening where can they find you online if they want to get in contact, find more of your work, see anything you're putting out is there a good places to go on the internet that they should be aware of?

Brenda Davy:	Sure. Well, I am on social media and I really like engaging with scientists and the general population related to dietary research, dietary assessment, and health outcomes research. I am using social media platforms, and so on Twitter I am @davybrenda and it's D-A-V-Y Brenda. I can also be found using for that's like Google Scholar or PubMed for those interested in looking at some of the specifics about the kind of research we do in our lab here at Virginia Tech.
Danny Lennon:	Awesome. I will link up to all of that in the show notes for people listening and you guys can go and check all of that out. So, with that Brenda that brings us to the very final question I always end the podcast on and this can be completely distinct from anything we've mentioned throughout the day's episode. It's more of a general life question I guess, and it's simply if you could advice people to do one thing each day that would have some benefit on any area of their life what would that one thing be?
Brenda Davy:	I'm going to have to say two things. I can't just say one because not only am I someone who studies nutrition I am also someone who is very interested in physical activity. So, I think being physically active every day in a way that you enjoy is something that's very important, and I think that that will allow you to better enjoy your food and probably also lead you to make better food choices and enjoy your food more. So, I will have to give you two things there be physically active and aim for a high quality diet overall.
Danny Lennon:	Perfect. With that Brenda thank you so much for taking the time to do this, and for the information you've given, and also for the continued great work that you are doing at the moment. Very much appreciate it.
Brenda Davy:	Sure. Thank you for having me.

Join Danny's FREE weekly email, the Sigma Synopsis:
https://sigmanutrition.com/sigma-synopsis/