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Research Paper

Food insufficiency and food insecurity as risk factors for physical disability among Palestinian refugees in Lebanon: Evidence from an observational study

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Abstract

Background: Potential interactions between malnutrition and disability are increasingly recognized, and both are important global health issues. Causal effects working from nutrition to disability and from disability back to nutrition present an empirical challenge to measuring either of these effects. However, disability affects nutrition whatever the cause of disability, whereas nutrition is likelier to affect disease-related disability than war- or work-related disability.

Objective: This paper investigates the association of food insufficiency with the risk of physical disability. Data on disability by cause allow us to address the difficulty of reverse causality.

Methods: Multinomial logit regressions of disability by cause on food insufficiency are run using survey data from 2010 on 2575 Palestinian refugee households in Lebanon. Controls include household sociodemographic, health and economic characteristics. Regressions of food insufficiency on disability by cause are also run.

Results: Disability has a significant coefficient in regressions of food insufficiency, whatever the cause of disability; but in regressions of disability on food insufficiency, food insufficiency is significant only for disease-related disability (log odds of disease-related disability .78 higher, $p = .008$). The difference in the results by cause of disability is evidence of a significant association between food insufficiency and disease-related disability, net of any reverse effect from disability to food access.

Conclusions: The association between disease-related disability and food insufficiency is statistically significant suggesting that even taking into account feedback from disability to nutrition, nutrition is an effective level of intervention to avert the poverty-disability trap resulting from the impoverishing effect of disability.

Keywords: Physical disability; Food insufficiency; Food insecurity

This paper investigates the association of food insecurity and food insufficiency with the risk of physical disability. We identify two broad strands in the literature linking food security and disability: studies that attempt to identify the effect of physical disability on food insecurity and nutrition more generally, and studies that focus on the reverse causal effect from poor nutrition to disability. Our study contributes to the latter strand by focusing on food insecurity and food insufficiency, and attempting to identify their effect on physical disability while taking into account the presence of a reverse causal effect from disability to food security and insufficiency. This two-way relationship between nutrition and disability is part of the larger health-wealth causal nexus and can contribute to pushing people vulnerable to food insufficiency/insecurity into a poverty-disability trap.

Both under-nutrition and overweight are global health problems that have implications on disease incidence, survival, and the healthy growth, development and productivity of individuals and populations.[1] The links between

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malnutrition and disability are increasingly recognized, and recent frameworks have analyzed the pathways by which these conditions are linked.[2]

The first strand in this literature focuses on the causal link from disability to nutrition, and identifies three channels of effect,[3] namely income, competing demands and coping ability. These channels are at work regardless of the cause of disability. There is evidence that income is lower and the poverty rate higher for the disabled.[4] This is often attributed to lower labor market participation of the disabled person and possibly other members in their household.[5,6]

The presence of a disability may create demand for competing goods and services that households with disabled members may trade-off essential food consumption in order to secure.[7] In addition, the special health care needs of people with disability places them at increased risk of nutritional problems including poor feeding skills, nutrient malabsorption, metabolic disorders and growth alterations.[2]

Finally, disability may compromise a household's ability to cope with food insecurity.[8,9] Using panel data, Ribar and Hamrick[10] find that disability is associated with a greater likelihood of entering food insecurity. Various barriers to eating well have been identified in the physically disabled and include the cost of food and difficulties in shopping for and cooking food.[11]

The literature focusing on the effect of nutrition on disability notes that this effect is greater at the two extremes of age (in children and the elderly); in older adults, up to 85% of the excess odds of disability can be explained by obesity and related cardio-metabolic risk factors.[12,13] Low protein intake, extremes of BMI, vitamin D status and low B-vitamin intakes have been found to be associated with disability and its risk factors in older adults.[14] In childhood, disability is more likely in children not breastfed, not receiving vitamin A supplements, and in those stunted or underweight.[15] One study which attempts to examine the relationship between disability, food security and health outcomes highlights the complex inter-relationships between these variables and finds health and food security to be significant in models of child disability but no effect of child disability in models of health or poverty.[16]

That food insecurity is associated with poor health outcomes, such as chronic conditions and poor self-rated health has been widely documented in various settings, including in refugee populations living in the Middle East region.[17–22]

This study hopes to identify the role of food insecurity and food insufficiency as a risk factor for disability by looking at the disability status and food insufficiency and insecurity indicators for a sample of Palestinian refugees in Lebanon. Palestinian refugees in Lebanon are protracted refugees that remain, until today, socially, politically and economically marginalized. They are a population that is at especially high risk of poverty, food insecurity and disability of various causes, compared to their Lebanese counterparts.[23] Food insecure Palestinian refugees were found to have reduced diet quality, and to resort to eating less and cheaper food and borrowing or receiving money or food.[18] The right to food, and the rights of people with disabilities are both key human rights issues, and establishing causal links between the two could contribute to establishing an evidence base that can inform future programs and policies to reduce avoidable nutrition-related disability,[2] particularly in vulnerable populations such as refugees.

The difficulty in quantifying the disability risk associated with food insecurity and insufficiency in cross-sectional data is that food insecurity or poor nutrition are not only risk factors for disability; but may also be the result of disability, through the channels identified above of income, competing goods and coping mechanisms. Our study hopes to overcome this problem of reverse causality by looking at any differences across causes of disability in the partial effects of disability on food insecurity.

Methods

Study design and covariates

A socio-economic survey was conducted by the American University of Beirut (AUB) and the United Nations Relief and Works Agency (UNRWA) in July–August 2010 on the living conditions of Palestinian refugees residing in Lebanon. This paper uses data from this survey and STATA 9.0 for Mac to run the statistical analyses. Table 1 lists the variables used with some summary statistics.

The survey covered 2575 eligible households living in 12 camps and 20 gatherings in five different areas: Central Lebanon Area, North, Saida, Tyre, and Bekaa. The survey used a clustered multi-stage sampling approach and households within clusters were then randomly selected by probability according to population size. Data collectors conducted a face-to-face interview with a proxy adult respondent from the household, most often a senior female member responsible for food preparation. The questionnaire included modules on demographics, education, employment, health status, food, housing, household assets and household expenditure. Some of the data on household durables were collected in an assets index.

Questions on food were used to assess household food security. Questions were derived from the 18-item U.S. Department of Agriculture (USDA) food security survey module and the Yemeni Food Security Questionnaire and were modified to the context of Palestinian refugees living in Lebanon. A food security scale was developed based on 6 questions and was internally validated using statistical methods based on the Rasch measurement model. The development and validation of this scale has been published elsewhere,[24] and the six questions included in the food

Table 1
Socio-demographic, health and food security characteristics of Palestinian refugee households included in the analysis

Variable	Mean	Std dev	N
Food insufficiency	.55	.50	2368
Insufficient food variety	.50	.50	2313
Food insecurity	.62	.49	2275
Expenditure per capita (in USD/month)	193	121	2381
Asset index	2.15	.65	2370
Household size	4.50	2.12	2381
Number of children <5 years	.32	.62	2381
Number of adults > 65 years	.47	.71	2381
Female headed household	.22	.42	2381
Education of household head			
<Primary	.47	.50	2381
Primary	.28	.45	
Intermediate	.09	.29	
Secondary	.05	.22	
University	.11	.31	
Number of chronic conditions in the household	1.36	1.12	2381
Household receives special assistance (non-UNRWA)	.13	.34	2374
Household receives special assistance (UNRWA)	.38	.48	2346
Household has a disabled member of known cause	.13	.34	2381
Household has a disabled member of "other" cause	.03	.16	2381
Region of residence			
North	.23	.42	2381
Central Lebanon	.22	.42	
Saida	.23	.42	
Tyre	.21	.41	
Beqaa	.10	.30	

security scale are listed in the data Appendix. Each positive response on any of these six questions was counted as one point in the food security scale and households were classified according to the total score: food secure (0–1), food insecure (2–4), and severely food insecure (5–6). The food security variable in this study is dichotomous and equal to 1 anytime a household scores 2 or more on the food security scale (i.e. any household classified as food insecure or severely food insecure). Food insufficiency and food quality were assessed using a positive response to the following questions respectively: "Were the following statements true for your household? The food that we bought just didn't last and we didn't have enough money to buy more," and "We had enough to eat but not always the kinds of food we wanted." In our analysis, we assess the effects of these variables separately as they represent specific thresholds of vulnerability whereas the food security score is better measure of composite risk.

The survey also collected data on the presence in the household of any member who reports having a chronic condition, or physical disability. Chronic conditions were specified by respondents, and the most commonly reported included hypertension, diabetes, high cholesterol/triglycerides, stroke, chest pain, vascular problems, chronic back pain, rheumatism, anemia, asthma, and cancer. The most commons forms of physical disability reported were disabilities of the extremities (30%), where paralysis (15%) and amputation (9%) were recorded separately, visual disabilities (9%) and hearing impairments (8%).[23] The cause of disability was recorded in the following categories: war, work, accident, birth or other. With war, work, accident and birth excluded, we took "other" to represent disability because of a health condition. We investigate the significance of food sufficiency and security as a determinant of this cause of disability in particular, as food security and sufficiency are thought to affect disability through health.

Statistical analyses

Table 1 lists the variables used with some summary statistics. The paper looks at the partial correlation between food insecurity and insufficiency and the risk of disability in models of disability. More specifically, in a multinomial logit model of disability by cause, the partial effects of food insecurity and insufficiency variables across disabilities of different causes are compared: this exercise is done to identify the disability risk associated with food insufficiency variables by comparing their association with disease-caused disability to their association with disabilities caused by more exogenous factors like war or accident, where they would be expected to have less of an effect.

The difficulty with implementing this approach is that to attribute disability risk to nutrition, one would ideally need to observe food insufficiency variables prior to the occurrence of the disability. In this cross-sectional dataset, it is not possible to observe these prior to the occurrence of the disability. Instead, the data are on current food variety, sufficiency and security. So for households that include a household member with a disability, the causal channel from disability to food insecurity/insufficiency will likely have altered the household's food situation so that the currently observed state may not accurately reflect food security and sufficiency prior to the occurrence of the disability. The concern is that any estimated coefficient for food insufficiency and insecurity on disability will be biased because of this reverse causality.

As mentioned above, the three causal channels identified in the literature from disability to food security and sufficiency work through earnings, competing demand for other goods and services, and a compromised ability to cope. All of these channels are at work, regardless of the cause of the disability. However, the sizes of the associations through each of these channels may be heterogeneous across causes of disability.

We investigate the seriousness of this problem by looking at the role of disability (by cause of disability) as a determinant of food insufficiency/insecurity: the reasoning here is that if the partial correlations of various cause disability as determinants of food insufficiency are uniform

Table 2
Regressions[a] of food insecurity variables on disability by cause (omitted category: disability from ''other causes'')

Dependent variable	Food insufficiency (1)	Insufficient food variety (2)	Food insecurity (3)
No disability	−.10[b] (.05)	−.05 (.06)	−.04 (.06)
Disability of known cause	−.04 (.06)	−.001 (.06)	−.001 (.06)
N	2317	2262	2224

[a] All regressions also control for: household size, per capita expenditures, asset index, the number of children under 5, the number of adults above 60, gender of household head, education of household head, the number of chronic conditions in the household, indicators for special assistance programs, and region fixed effects.
[b] Significant at the 10% level.

across disability causes, reverse causality affects our estimators of the partial correlations of food insufficiency/insecurity as determinants of disability uniformly across causes of disability.

It should first be noted that there are no assistance programs specifically targeted at disabilities from war, accident, work, or birth. The association between disability by cause and food security and sufficiency is therefore examined while controlling for household size and demographic characteristics, household expenditures per capita and household wealth, as well as the presence of chronic conditions in the household. Indicator variables for whether the household receives assistance from a special hardship program are also included. In Table 2, the dependent variables are an indicator of food insufficiency in column (1), an indicator of insufficient food variety in column (2) and an index of food insecurity in column (3).

The main variable of interest measures disability by cause through three dummy variables: ''no disability,'' for households who have no disabled members, ''disability of known cause,'' for households who report a disabled member from war, work, accident or birth, and ''disability of unknown cause,'' the excluded category in the regressions, for households who report a disabled member from ''other'' causes. The coefficient on ''disability of known cause'' therefore shows any difference in the association between disability and the dependent variable between disabilities of known causes and those of other causes.

If the results show partial correlations that are uniform across causes of disability, we take the reverse causality bias in our main regression of interest of disability on food insufficiency and food insecurity to be uniform across disability causes. Based on the findings from this initial regression, and if the results show uniform partial correlations between each cause disability and food insufficiency/insecurity, the empirical strategy is then to estimate the association of current food security status to the relative odds of disability by cause, and to look for any differences in the significance of results across causes.

Table 3 presents the results from running a series of multinomial regressions of the three categories of disability: ''no disability,'' ''disability of known cause,'' and ''disability of other cause.'' The omitted category is the absence of disability, so Table 3 shows the associations between the regressors on the log odds of ''disability of known cause'' and the log odds of ''disability of other cause,'' both relative to ''absence of disability.'' The regressors of interest are the indicator variables of food insufficiency, insufficient food variety, and severe food insecurity. The control variables include household demographic characteristics, including some characteristics of the household head, household expenditures per capita and a household wealth index based on the ownership of assets. Region fixed effects are included to control for any heterogeneity across the regions of North, Central, South and Eastern Lebanon.

The approach used in this paper has limitations: the cause of disability is identified as ''disease'' by elimination

Table 3
Multinomial logit regression[a] of disability (excluded outcome: no disability)

	(1)	(2)	(3)	(4)	(5)
Panel A: disability of known cause					
Insufficient food	.20 (.16)	.21 (.20)	.19 (.16)	.19 (.20)	
Insufficient food variety	.23 (.16)	.23 (.19)	.22 (.17)	.22 (.19)	
Food insecurity		−.02 (.25)		−.02 (.26)	.26 (.16)
Chronic condition			.05 (.06)	.06 (.06)	.07 (.06)
Panel B: disability of unknown cause					
Insufficient food	.63[c] (.29)	.78[d] (.29)	.55[b] (.29)	.68[c] (.24)	
Insufficient food variety	.11 (.29)	.26 (.39)	.06 (.29)	.18 (.38)	
Food insecurity		−.38 (.40)		−.32 (.40)	.26 (.31)
Chronic condition			.30[d] (.10)	.29[d] (.10)	.31[d] (.10)
N	2249	2224	2249	2224	2224

[a] All regressions also control for: household size, per capita expenditures, asset index, the number of children under 5, the number of adults above 60, gender of household head, education of household head, indicators for special assistance programs, and region fixed effects.
[b] Significant at the 10% level.
[c] Significant at the 5% level.
[d] Significant at the 1% level.

from all other explicitly listed causes of disability. A significant association between food insufficiency and disability from disease is established, but an unbiased estimate of the magnitude of this effect would require longitudinal data. Cross-sectional data offer a snapshot rather than a dynamic view of the inter-relationships between food insufficiency and disability. With no information on the duration of disability, the association between disability and nutrition cannot be qualified by length of exposure. Also, longer-term relationship between nutrition and disability through intergenerational effects are missed. Furthermore, the context of Palestinian refugees living in camps in Lebanon is quite unique: this is a community deprived of basic economic, political and social rights in a middle-income country. Physically, the camps have poor infrastructure, are overcrowded and offer few public amenities in terms of utilities and public services. To the extent that the peculiar institutional, environmental, and political context of this sample shape the relationship between food access and sufficiency on the one hand, and disability on the other hand, the generalizability of the results obtained is limited.

Results

Table 1 presents the sociodemographic, food security and health characteristics of households surveyed. 55% of households had food insufficiency, whereas close to 62% were food insecure. 13% of households had a member with a known cause of disability, whereas 3% of households included a disabled individual of "other" cause.

In the regressions in Table 2 of nutritional profile variables on disability by cause, the excluded disability category is "disability of unknown cause," therefore the coefficient on the "no disability" (disability of known cause) indicator is measuring any difference in the association between households with no disability (with a disability of a known cause) and households with a disability of unknown cause. The results indicate that disability is associated with a higher risk of reporting insufficient food, insufficient variety and severe food insecurity as the coefficient on the indicator of no disability is consistently negative, relatively large in magnitude and significant as a determinant of food insufficiency. Thus households with no disabled members when compared to households with a disability from an unknown cause, are associated with a 10% lower risk of food insufficiency (column 1), a 5% lower risk of insufficient food variety (column 2) and a 4% lower risk of food insecurity (column 3). A disability of a known cause is associated with slightly lower scores on all the food risk measures, but this difference is not statistically significant in any of the regressions.

So while disability has a statistically significant negative association with nutrition as measured by food insufficiency, *that association doesn't depend on the cause* of the disability: the coefficient of disability of known cause (measuring the difference between known and unknown causes in the association of disability to nutrition) is never significant in any of the regressions of nutritional variables.

These results are taken as indication that the current food security status of households with a disabled member is worse than the food security status before the occurrence of the disability, even controlling for household expenditures and assets, and for the presence of chronic health conditions in the household, however, this nutritional deficit seems similar across causes of disability.

Given that the partial correlations between disability and food insecurity are uniform across all disability causes, we proceed to estimate in Table 3 the regressions of interest, of disability by cause on food insufficiency and insecurity. In these regressions, any non-uniformity across causes in the coefficients of food insufficiency and food insecurity on the risk of disability are investigated.

Multinomial logit regressions of disability by cause on food insufficiency and insecurity are reported in Table 3. In column (1), the coefficient on food insufficiency is positive in both panels, where an insufficiency score of 1 is associated with 0.2 higher log odds of disability of known cause (compared to no disability) and .63 higher log odds of disability of unknown cause (compared to no disability). However, this association is only significant in the bottom panel, as a correlate of disability of unknown cause.

In column (2) we add a binary indicator of food insecurity to check whether vulnerabilities to insecurity other than insufficiency and poor quality may be associated with the relative risks of disability by cause. The results are qualitatively similar: the indicator of food insufficiency remains an insignificant determinant of the relative log odds of known cause disability, and it remains a significant and positive determinant of the relative log odds of disability from unknown causes, even when we control for food insecurity. The other two food-related variables are insignificant in both panels. In column (2), the result from column (1) can be qualified to say that even holding fixed our indicators of food insecurity and insufficient variety, food insufficiency is associated with a significantly higher risk of other-cause disability.

In order to try to understand the mechanism at work, columns (3) and (4) repeat the same regressions in columns (1) and (2) but we include as a control a variable measuring the number of chronic conditions in the household. In Panel B, for disabilities of unknown cause, the magnitude of the associations is slightly smaller in the next two columns when we control for chronic conditions, with the coefficient of food insufficiency going from .63 (in column 1) to .55 (in column 3), and from .78 (in column 2) to .68 (in column 4) when we control for both food insecurity and chronic conditions. Even when we control for chronic conditions, food insufficiency still shows a significant association with the relative odds of disability from "other" causes, and no significant association with the relative odds of disability from known causes.

Our measure of chronic conditions itself is only significantly and positively associated with the relative odds of "other"-cause disability.

The last column in Table 3 includes only our food insecurity variable in order to test whether the findings for food insufficiency in the previous columns are because food insufficiency is standing in for other aspects of food insecurity. Column (5) shows that food insecurity alone is not significantly associated with either relative odds of disability, suggesting that it is food insufficiency specifically that is correlated with a higher risk of disability from disease.

Sensitivity analysis

Table 4 checks the robustness of the results in Table 3 to a variety of changes in the control variables and in the measurement of disability.

In columns (1) and (2), we vary our control for the household's socio-economic status. Column (1) repeats the regression from column (4) in Table 3 but omits the assets indicator. The results are qualitatively similar to the results from the more complete regression: of all of our food insecurity variables, food insufficiency is still the only significant determinant of the log odds of disability, and only for disability of "other" causes. Column (2) uses the natural logarithm of household expenditures per capita instead of including expenditures linearly. Again, this doesn't affect the main result.

In column (3), we omit the dummy variable measuring the number of individuals under 5 in the household: in Table 3, this variable consistently has a negative coefficient, but is never significant. Its exclusion doesn't change the significance results for the food insecurity variables.

Columns (4) and (5) exclude the indicator variable for households receiving special in kind or cash assistance. There are two such variables, one for UNRWA's Special Hardship Assistance Program, a program designed to assist the poorest refugee families with a small monthly cash transfer and food basket, and the other for all other such assistance programs. In Table 3, these variables are always associated with higher odds of disability but only consistently significant in regressions of known-cause disability. Column (4) excludes the variable related to UNRWA's program; column (5) excludes both variables. When these variables are excluded, the results for the three measures of food insecurity remain as they were in Table 3: food insufficiency is the only significant determinant of the log odds of disability, and only for disability of "other" causes.

In column (6), we count as disabled from "other" causes only individuals below the age of 65 in order to exclude from "other" cause disability anyone disabled from "old age" and to focus on disability from disease. The results are qualitatively similar to those in Table 3 with food insufficiency still significant, but only as a determinant (now with larger magnitude) of the relative log odds of "other" cause disability.

Discussion

When the associations of food insecurity, insufficiency and insufficient variety in the regression known cause disability is contrasted to their coefficients in the regression of disability of "other" causes, food insufficiency and insufficient food variety are not significant in predicting the relative odds of known-cause disability. By contrast, food insufficiency is significant in predicting the relative log odds of unknown cause disability. Furthermore, the magnitudes of the associations of the nutrition variables are higher in the case of disability of unknown cause. There seems to be a significant and positive association between

Table 4
Multinomial logit regressions[a] of disability (excluded outcome: no disability)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: disability of known cause						
Insufficient food	.18 (.20)	.19 (.20)	.17 (.20)	.22 (.20)	.19 (.20)	.21 (.19)
Insufficient food variety	.20 (.19)	.21 (.19)	.22 (.19)	.21 (.19)	.22 (.19)	.19 (.18)
Food insecurity	−.01 (.26)	.01 (.26)	−.01 (.26)	.05 (.26)	.10 (.26)	−.03 (.25)
Panel B: disability of other causes						⩽65 years
Insufficient food	.68[b] (.30)	.67[b] (.29)	.66[b] (.30)	.67[b] (.29)	.68[b] (.29)	.90[c] (.29)
Insufficient food variety	.18 (.38)	.17 (.38)	.17 (.39)	.20 (.39)	.25 (.40)	.50 (.46)
Food insecurity	−.31 (.40)	−.36 (.40)	−.32 (.40)	−.28 (.40)	−.28 (.40)	−.38 (.42)
Assets	No	Yes	Yes	Yes	Yes	Yes
Expenditures per capita	Yes	No	Yes	Yes	Yes	Yes
Ln (expenditures/cap)	No	Yes	No	No	No	No
Number of children < 5 years	Yes	Yes	No	Yes	Yes	Yes
Receives assistance (UNRWA)	Yes	Yes	Yes	No	No	Yes
Receives assistance (non-UNRWA)	Yes	Yes	Yes	Yes	No	Yes
N	2235	2224	2224	2257	2264	2224

[a] All regressions also control for: household size, the number of adults above 60, gender of household head, education of household head, the number of chronic conditions in the household, and region fixed effects.
[b] Significant at the 5% level.
[c] Significant at the 1% level.

food insufficiency and the risk of disability from "other" causes, which are disabilities most likely disease-related, and no equivalent association between food insufficiency and disability from non-disease related causes.

Furthermore, the finding that chronic conditions, as a control, are only significant in regressions of unknown-cause disabilities, and insignificant as correlates of disability from known cause confirms the hypothesis that, given the list of "known" causes (war, accident, work, birth), the category "other" cause is likely mostly capturing disability from disease.

The contrast in the significance of the results across causes of disabilities persists when we control for food insecurity, for chronic conditions, and for food insecurity and chronic conditions.

It is not surprising to find that of all the measures of food insecurity, across the various specifications in Table 3, it is the measure of insufficiency that turns out to be significant: if these variables are capturing thresholds of vulnerability, then food insufficiency is likely the most severe of these thresholds.

The difference in the significance of the results across causes of disability is suggestive of an association between food insufficiency and specifically "other"-cause disability.

Furthermore, the results in Table 4 suggest that this association is over and above whatever association comes from the link between food insufficiency, chronic conditions and disability. This association may be through the channel of acute, immuno-mediating or other effects and their link to disability.

Conclusions

Parsing out the associations between a set of measures of food insecurity and disabilities by causes reveals the existence of a consistently significant and positive partial correlation between food insufficiency and disability specifically due to disease, even when controlling for chronic health conditions and household socio-economic status.

What is already widely known in the literature about the severely impoverishing effects of disability (regardless of cause) suggests that prevention against disability from avoidable causes may be an especially effective node of intervention to break the poverty trap that households with disabled individuals are prone to fall in.

To the extent that we think of disability from disease is more "avoidable" through household- and individual-level intervention than disability from war, accident or birth, finding a strong association of disability from disease with food insufficiency, which is consistently absent for disability from non disease-related causes, would suggest a locus for intervention that could potentially be more effective at preventing disease-related disability, and the shock to the health-wealth spiral that its impoverishing effects are likely to cause. Thus, the uncovering in this context of the strong statistical association between disability from disease and food insufficiency that the household data on Palestinian refugees in Lebanon confirm, even holding constant household expenditures, goes further toward proposing a specific form of intervention at the juncture in the poverty cycle preceding disability for a population that is especially vulnerable.

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Supplementary data

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References

1. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382(9890):427–451.
2. Groce N, Challenger E, Berman-Bieler R, et al. Malnutrition and disability: unexplored opportunities for collaboration. *Paediatr Int Child Health*. 2014;34(4):308–314.
3. Heflin CM, Corcoran ME, Siefert KA. Work trajectories, income changes, and food insufficiency in a Michigan welfare population. *Soc Serv Rev*. 2007;81(1):3–25.
4. Kavanagh AM, Krnjacki L, Aitken Z, et al. Intersections between disability, type of impairment, gender and socio-economic disadvantage in a nationally representative sample of 33,101 working-aged Australians. *Disabil Health J*. 2015;8(2):191–199.
5. Mitra S, Posarac A, Vick B. Disability and poverty in developing countries: a multidimensional study. *World Dev*. 2013;31(41):1–8.
6. Wang Q. Disability and American families: 2000. *Bulletin*. 2005;62(4):21–30.
7. Coleman-Jensen A, Nord M. Disability is an important risk factor for food insecurity. *Amber Waves*. 2013;1:34–39.
8. Cummins RA. The subjective well-being of people caring for a family member with a severe disability at home: a review. *J Intellect Dev Disabil*. 2001;26(1):83–100.
9. Power PW, Orto AED. *Families Living with Chronic Illness and Disability: Interventions, Challenges, and Opportunities*. Springer Publishing Company; 2004.
10. Ribar DC, Hamrick KS. *Dynamics of Poverty and Food Sufficiency*. Washington, DC: US Department of Agriculture, Economic Research Service; 2003.
11. Hall L, Colantonio A, Yoshida K. Barriers to nutrition as a health promotion practice for women with disabilities. *Int J Rehabil Res*. 2003;26(3):245–247.
12. Kalyani RR, Saudek CD, Brancati FL, Selvin E. Association of diabetes, comorbidities, and A1C with functional disability in older adults: results from the National Health and Nutrition Examination Survey (NHANES), 1999-2006. *Diabetes Care*. 2010;33(5):1055–1060.
13. Seeman TE, Merkin SS, Crimmins EM, Karlamangla AS. Disability trends among older Americans: National Health And Nutrition

Examination Surveys, 1988-1994 and 1999-2004. *Am J Public Health*. 2010;100(1):100–107.
14. Mithal A, Bonjour JP, Boonen S, et al. Impact of nutrition on muscle mass, strength, and performance in older adults. *Osteoporos Int*. 2013;24(5): 1555–1566.
15. Gottlieb CA, Maenner MJ, Cappa C, Durkin MS. Child disability screening, nutrition, and early learning in 18 countries with low and middle incomes: data from the third round of UNICEF's Multiple Indicator Cluster Survey (2005-06). *Lancet*. 2009;374(9704):1831–1839.
16. Shahtahmasebi S, Emerson E, Berridge D, Lancaster G. Child disability, parental self-rated health and food security: a multivariate cross-sectional analysis. *Int J Disabil Hum Dev*. 2009;8(4):417–434.
17. Ghattas H, Sassine AJ, Seyfert K, Nord M, Sahyoun NR. Food insecurity among Iraqi refugees living in Lebanon, 10 years after the invasion of Iraq: data from a household survey. *Br J Nutr*. 2014;112(01):70–79.
18. Ghattas H, Sassine AJ, Seyfert K, Nord M, Sahyoun NR. Prevalence and correlates of food insecurity among Palestinian refugees in Lebanon: data from a household survey. *PLoS One*. 2015;10(6):e0130724.
19. McIntyre L, Connor SK, Warren J. Child hunger in Canada: results of the 1994 National Longitudinal Survey of Children and Youth. *CMAJ*. 2000;163(8):961–965.
20. Siefert K, Heflin CM, Corcoran ME, Williams DR. Food insufficiency and the physical and mental health of low-income women. *Womens Health*. 2001;32(1–2):159–177.
21. Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. *J Nutr*. 2001;131(10):2670–2676.
22. Vozoris NT, Tarasuk VS. Household food insufficiency is associated with poorer health. *J Nutr*. 2003;133(1):120–126.
23. Chaaban J, Ghattas H, Habib R, et al. *Socio-economic Survey of Palestinian Refugees in Lebanon*. Beirut: UNRWA. Available at: http://www.unrwa.org/userfiles/2011012074253.pdf; 2010. Accessed 16.11.15.
24. Sahyoun NR, Nord M, Sassine AJ, Seyfert K, Hwalla N, Ghattas H. Development and validation of an Arab family food security scale. *J Nutr*. 2014;144(5):751–757.