

Original Article

# Predictors and Outcomes Associated with Household Hunger in Lusaka, Zambia: Secondary Analysis of a Citywide Survey

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## ABSTRACT

**Background:** Food insecurity has important social and health consequences for affected individuals and households. We sought to measure one aspect of food insecurity—household hunger—and evaluated its possible association with household morbidity and mortality.

**Methods:** We analyzed data from the final two rounds of a repeat cross-sectional, population-based survey conducted in Lusaka Zambia (May and August 2011). Using the Household Hunger Scale, we categorized participating households into three groups using established convention in the public health literature: little to no hunger, moderate hunger, and severe hunger. We used multilevel logistic regression to investigate associations between household hunger and the following morbidities, adjusting for individual, household, and cluster characteristics: malaria, persistent cough, tuberculosis, diarrhea, hospitalization, and death.

**Results:** Overall, 90.0%, (95%CI: 88.1–91.7%) participating households were considered to have little to no household hunger; 9.8% (95%CI:

8.2–11.6%) reported moderate household hunger; and 0.2% (95%CI: 0.1–0.4%) reported severe household hunger. Marital status, functional status, education, employment, household member requiring nursing care, and household wealth index were associated with all levels of hunger. Adjusted for individual and household characteristics and sampling cluster, hunger was associated with malaria (OR:1.29, 95%CI:1.03–1.63 [mild] and OR:3.68, 95% CI:1.76 –13.74 [severe]), persistent cough (OR:1.64, 95%CI:1.13–2.38 [mild]), tuberculosis (OR:2.24, 95%CI:1.45–3.46 [mild], OR:6.06; 95%CI:1.56–23.57 [severe]), and hospitalization (OR:1.95; 95%CI:1.38–2.76 [mild]; OR:5.52; 95%CI:1.78–17.16 [severe]). Household hunger was not associated with death ( $p>0.05$ ).

**Conclusions:** Household hunger was associated with a number of adverse health outcomes. Although further studies are needed, our findings suggest that programs to alleviate household hunger—an important aspect of food insecurity—could lead to measurable public health impacts.

## LIST OF ABBREVIATIONS

DHS Demographic and Health Survey  
HFIAS Household Food Insecurity Access Scale  
HHS Household Hunger Scale  
HOH Head of household

**Key Words:** Household hunger scale, HHS, health outcomes, Zambia, sub-Saharan Africa, food insecurity

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## DECLARATIONS

Ethical approval and consent to participate: All procedures were approved by the University of Zambia Biomedical Research Ethics Committee (Lusaka, Zambia) and the University of North Carolina at Chapel Hill Institutional Review Board (Chapel Hill, NC, USA). Written informed consent was obtained from all participants.

Consent for publication: Not applicable

Availability of data and material: The data sets analyzed during the current study are not yet in the public domain, though the process to do so has begun. However, we will make these available upon reasonable request to the corresponding author.

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## INTRODUCTION

Approximately 800 million people worldwide are undernourished and at elevated risk for illness and death.<sup>1,2</sup> Undernourishment and hunger have been a focus of the global community; both were included by the United Nations in its Millennium Development Goals (Goal 1) and Sustainable Development Goals (Goal 2). Although significant achievements have been made to eliminate hunger, sustained progress will likely require continued investment, broad coordination, and novel, multi-sectorial approaches.<sup>3</sup>

Food security is achieved when “all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”.<sup>4</sup> When these requirements are not met, in either a chronic or transitory state, the resulting condition is often described as food insecurity. Food insecurity is an important determinant of undernourishment and has been used as an important proxy measure in monitoring efforts. It can be assessed using different tools which vary in their domain of focus (e.g., food availability, food access, food utilization) and intent (e.g., monitoring population trends).<sup>5,6</sup>

While food insecurity has been associated with undernourishment throughout the life span and in many settings<sup>7-10</sup>, few studies have demonstrated direct links to population morbidity and mortality, particularly in sub-Saharan Africa. In this report, we analyzed data from a large community-based survey to study one aspect of food insecurity – that is, food access – in an urban African setting. We sought to describe the prevalence, predictors, and health consequences associated with household hunger at the population-level. We hypothesized that key socioeconomic factors would be associated with household hunger and that household hunger would be, in turn, related to increased risk for morbidity and mortality.

## METHODS

### Study setting and data collection

We analysed data from a citywide household survey designed to measure trends in population mortality during the scale-up of HIV care and treatment in Lusaka, Zambia. The methodology and results from the parent study have been reported elsewhere<sup>11-14</sup>. Briefly, from November 2004 to September 2011, we conducted 12 rounds of a serial cross-sectional household survey, each independently sampled. Using standard enumeration areas created by Zambia's Central Statistical Office, we divided the Lusaka urban district into 24 "catchment" areas, each associated with a public-sector clinic or hospital. In each survey round, three enumeration areas were selected from each catchment area using probability-proportional-to-size-sampling. Within each enumeration area, surveyors identified a central point and worked outward at regular intervals – based on the estimated population size – until they reached 50 households. If interviewers were unable to contact the head of household (HOH) after three attempts or if the HOH declined to participate, the neighbouring house was selected as a replacement. Overall, 3600 households were randomly selected for each round. At each sample household, the purpose of the survey was explained to the HOH and written consent was obtained. If both the male and female HOH were available, we prioritized the latter because, in our setting, women are generally more knowledgeable about the health of household members. Our survey instrument was adapted from the Zambia Demographic and Health Survey (DHS) and included questions about sociodemographic characteristics, health conditions, health services utilization, and knowledge, attitudes, and practices related to HIV.

### Household hunger assessment

In the final two rounds of the survey (May 2011 and August 2011), we amended the survey instrument to include Version 3.0 of the Household Food Insecurity Access Scale (HFIAS)<sup>15</sup>. The Household Hunger Scale (HHS) focuses on one aspect of food insecurity – that is, the food quantity dimension of

food access<sup>16</sup> – and is derived from three HFIAS questions: (a) in the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food? (b) in the past four weeks did you or any household member go to sleep at night hungry because there was not enough food? (c) in the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? If any of the questions were answered affirmatively, then study staff asked how often they occurred. The HHS can be used to estimate the prevalence of severe food insecurity<sup>16</sup>. However, unlike the classifications of food insecurity using the HFIAS scale (which must be adapted and validated to new settings), the concept of household hunger has been validated for cross-cultural use<sup>16</sup>.

### Exposure variables and health outcomes

We assessed key characteristics at the respondent and household levels. Individual-level respondent characteristics included gender, age, marital/cohabitation status, functional status, education, and work. Household characteristics included the presence of a household member who required nursing care, relocation of the household within the past 12 months, spraying of the household to kill mosquitoes within the past 12 months, the household dependency ratio, and an asset index. The dependency ratio was calculated by dividing the number of household members under the age of 15 and over the age of 65 by the number of household members between age 15 and 65. The asset index was a composite score serving as a proxy indicator of household economic status. Adapted from the Zambia DHS<sup>17</sup>, we included specific questions such as housing quality and asset lists, and utilized the sum of these items from principal component analysis to create an asset index using methods described by Vyas and Kumaranayake<sup>18</sup>. HOHs were asked if they had at least one member in their house that had specific morbidities within the past 3 months of the survey: malaria, persistent cough for more than two weeks, diarrhea, tuberculosis, and any hospitalization. They were also asked if any household member died within the past 12 months.

## Statistical Analysis

Based on HHS classifications, we categorized each household into one of three groups: little to no hunger, moderate hunger, and severe hunger. For individual and household characteristics, we reported overall estimates, followed by comparisons across these different household hunger strata. To assess statistical differences between these groups, we used Chi-squared tests for categorical variables and non parametric tests for equality of medians.

We sought to identify characteristics associated with household hunger. Because of the relatively small number of households that met criteria for severe hunger (see below), we created a binary variable for this analysis. Specifically, those with little to no household hunger were compared to those reporting moderate to severe household hunger. We used multivariable mixed effects models, adjusting for survey round and catchment area.

We estimated proportions of households reporting household mortality over the last 12 months, as well as following co-morbidities over the past three months: malaria, persistent cough for more than two weeks, treatment for diarrhea, treatment for tuberculosis, and hospitalization. Household members were asked to report on all household members over these time periods. Proportions were adjusted to account for sampling design.

We then measured the association between household hunger with each outcome in separate models. We used multivariable mixed effects models, adjusting for covariates that were significantly associated with household hunger. These included respondent characteristics (age, marital/cohabitation status, functional status, education, work) and household characteristics (household dependency ratio, household asset index, relocation in past 12 months, household member requiring care, survey round), and this was further adjusted by catchment area. The model for the malaria outcome also adjusted for report of household insecticide spraying. All statistical analyses were performed with Stata version 14.1 (StataCorp LP, College Station, Texas, USA).

## RESULTS

Overall, 7200 households were included in the final two rounds of the Lusaka Community Health Survey (May 2011 and August 2011) and included in our analysis. Of these, only 226 (3.1%) households represented replacement households. Most of participating HOHs were women (82.9%), aged 26-35 years (43.0%), living with a partner (73.2%), and reported being healthy (95.1%). Nearly half had attained a secondary school education level (44.8%) and a similar proportion reported working in the home (45.6%). The median household dependency ratio was 0.50 (interquartile range [IQR] 0.17-1.00) and the vast majority (90.3%) had not relocated in the previous 12 months. Other characteristics of the HOH and household are shown in Table 1.

### Prevalence and predictors of household hunger

Overall, 6677 of 7169 (survey weighted proportion: 90.0%, 95%CI: 88.1–91.7%) participating households with available food insecurity data were considered to have little to no household hunger; 471 (survey weighted proportion: 9.8%; 95%CI: 8.2–11.6%) reported moderate household hunger; and 21 (survey weighted proportion 0.2%, 95%CI: 0.1–0.4%) reported severe household hunger. In univariate analysis, factors associated with household hunger included age, marital status, functional status, education, work, dependency ratio, relocation in past 12 months, household member requiring nursing care, asset index, and survey round (Table 1). In multivariable analysis, many remained statistically significant, including those factors suggesting lower socioeconomic status and/or less socioeconomic stability (Table 2).

### Health outcomes and their association with household hunger

In Figure 1, we show the proportion of households that reported co-morbidities over the past three months and deaths over the past 12 months. Among these specific illnesses, malaria was most frequently reported (22.9%, 95%CI: 20.6–25.2%), followed by persistent cough for more than two weeks (9.4%, 95%CI: 8.0–11.2%), treatment for diarrhea (5.2%,

**Table 1: Unadjusted individual respondent and household characteristics among participants in final two rounds of the Lusaka Community Health Survey (May 2011, August 2011).**

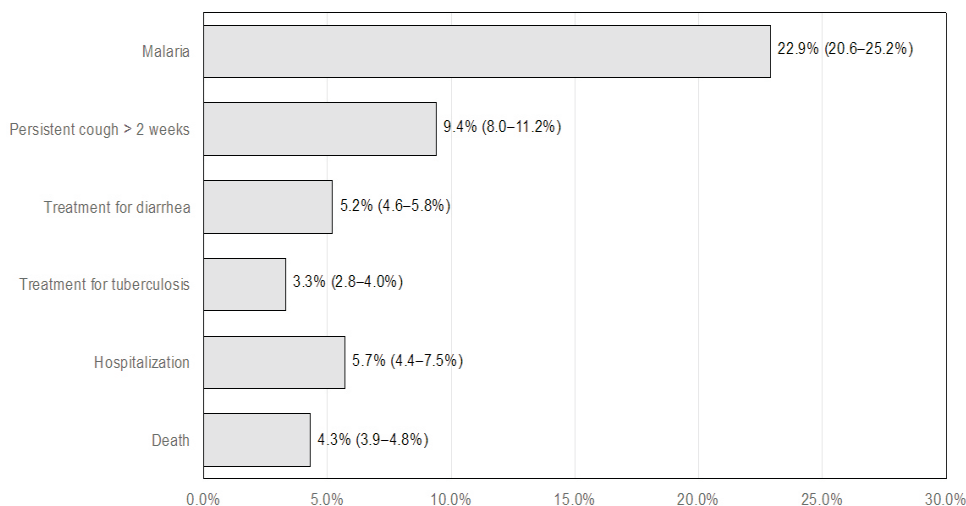
	Overall		Little to no household hunger		Moderate household hunger		Severe household hunger		P-value
	N	%	N	%	N	%	N	%	
<b>Individual Characteristics</b>									
Gender									0.06
Men	1229	17.1%	1152	17.3%	70	14.9%	7	33.3%	
Women	5940	82.9%	5525	82.8%	401	85.1%	14	66.7%	
Age									<0.01
<25	1432	20.0%	1139	20.1%	88	18.7%	5	23.8%	
26-35	3083	43.0%	2901	43.5%	179	38.0%	3	14.3%	
36-45	1460	20.4%	1358	20.3%	99	21.0%	3	14.3%	
46-55	746	10.4%	682	10.2%	59	12.5%	5	22.8%	
>55	448	6.3%	397	6.0%	46	9.8%	5	23.8%	
Marital status									0.01
Living with partner	5248	73.2%	4915	73.6%	320	67.9%	13	61.9%	
Not living with partner	1921	26.8%	1762	26.4%	151	32.1%	8	38.1%	
Functional status									<0.01
Unable to work/go to school	127	1.8%	106	1.6%	17	3.6%	4	19.1%	
Sick but able to work/go to school	228	3.2%	177	2.7%	47	10.0%	4	19.1%	
Healthy	6814	95.1%	6394	95.8%	407	86.4%	13	61.9%	
Education									<0.01
None	269	3.8%	223	3.3%	42	8.9%	4	19.1%	
Primary (1-7 years)	1560	12.8%	152	22.8%	39	8.3%	1	4.8%	
Secondary (8-12 years)	2060	28.7%	1837	27.5%	212	45.0%	11	52.4%	
Post-secondary (12+ years)	3280	45.8%	3097	46.4%	178	37.8%	5	23.8%	
Usual work									<0.01
For salary	1884	26.5%	1804	27.2%	76	16.5%	4	21.1%	
In home	3240	45.6%	3003	45.3%	228	49.6%	9	47.4%	
Other	1989	28.0%	1827	27.5%	156	33.9%	6	31.6%	
<b>Household Characteristics</b>									
Dependency ratio (median, IQR)	7148	0.50 (0.17-1.00)	6665	0.50 (0.17 - 1.00)	468	0.50 (0.18-1.00)	20	1.00 (0.25-1.29)	0.72
Household relocated in last 12 months									0.05
No	6475	90.3%	6017	90.1%	437	92.8%	21	100.0%	
Yes	694	9.7%	660	9.9%	34	7.2%	0	0.0%	
Household member requires nursing care									<0.01
No	7017	97.9%	6561	98.3%	436	92.6%	20	95.2%	
Yes	152	2.1%	116	1.7%	35	7.4%	1	4.8%	
Household sprayed to kill mosquitoes in last 12 months									0.06
No	4848	67.6%	4532	67.9%	306	65.0%	10	47.6%	
Yes	2321	32.4%	2145	32.1%	165	35.0%	11	52.4%	
Overall household asset index									<0.01
High	2379	33.2%	2319	34.7%	59	12.5%	2	9.5%	
Middle	2835	39.6%	2659	39.8%	173	36.7%	3	14.3%	
Low	1955	27.3%	1700	25.5%	239	50.7%	16	76.2%	
Survey round									<0.01
May 2011	3576	49.9%	3247	48.6%	309	65.6%	20	95.2%	
August 2011	3593	50.1%	3430	51.4%	162	34.4%	1	4.8%	

**Table 2: Association between moderate to severe household hunger and various individual-level and household-level characteristics.**

	<b>Adjusted odds ratio (95% confidence interval)*</b>
<b>Individual Characteristics</b>	
Gender	
Men	Ref
Women	1.08 (0.82 - 1.43)
Age	
<25	Ref
26-35	1.25 (0.95 - 1.65)
36-45	1.57 (1.15 - 2.14)
46-55	1.94 (1.36 - 2.78)
>55	2.18 (1.43 - 3.32)
Marital status	
Living with partner	Ref
Not living with partner	1.29 (1.04 - 1.61)
Functional status	
Healthy	Ref
Sick but able to work/go to school	2.97 (2.08 - 4.23)
Unable to work/go to school	1.93 (1.13 - 3.30)
Education	
None	Ref
Primary (1-7 years)	0.91 (0.62 - 1.34)
Secondary (8-12 years)	0.64 (0.43 - 0.97)
Post-secondary (12+ years)	0.49 (0.29 - 0.85)
<b>Household Characteristics</b>	
Dependency ratio**	0.94 (0.81 - 1.09)
Household relocated in last 12 months	
No	Ref
Yes	0.75 (0.52 - 1.10)
Overall household asset index	
High	Ref
Middle	1.89 (1.32 - 2.71)
Low	3.36 (2.30 - 4.92)

\* The multivariable mixed effects model included all the listed characteristics and was also adjusted for survey round and catchment area. \*\* The dependency ratio in the household is calculated by dividing the number of children and people over age 65 divided by the number of individuals aged 15-65. It included as a continuous variable in this model.

**Figure 1:** Proportion of households that reported at least one family member with mortality or specific co-morbidity in the final two rounds of the Lusaka Community Health Survey (May 2011, August 2011), adjusted for survey design. Point estimates (with 95% confidence intervals) are shown for each specific condition. We asked respondents about specific comorbidities (malaria, persistent cough, diarrhea, tuberculosis, hospitalization) over the past three months and deaths over the past 12 months.



95%CI: 4.6–5.8%), and treatment for tuberculosis (3.3%, 95%CI: 2.8–4.0%). In addition, 5.7% (95%CI: 4.4–7.5%) reported the hospitalization of a household member over the past three months; 4.3% (95%CI: 3.9–4.8%) reported a death over the past 12 months.

We constructed separate multivariable mixed effect models to investigate potential associations between household hunger and health outcomes (Table 3). When compared to those with little to no household hunger, those with moderate and severe household hunger were more likely to report the illnesses listed above. We consistently observed a dose-dependent effect, with magnitude of risk associated with increasing severity of household hunger. This trend was also observed with our mortality outcome; however, it did not reach statistical significance.

**DISCUSSION**

In this population-based survey, moderate to severe household hunger was reported by 10% of respondents. The individual and household characteristics associated with hunger were related to lower socioeconomic status and/or less

**Table 3:** Association between household hunger and reported mortality or co-morbidity, reported as adjusted odds ratio (with 95% confidence interval). Each row represents a separate multivariate mixed effects model; each includes specific respondent characteristics (age, marital status, functional status, education, work) and household characteristics (household dependency ratio, household asset index, relocation in past 12 months, household member requiring care, survey round), allowed to vary by catchment area. The model for the malaria outcome also adjusted for report of household insecticide spraying. We asked respondents about specific comorbidities (malaria, persistent cough, diarrhea, tuberculosis, hospitalization) over the past three months and deaths over the past 12 months.

	Little to no hunger in household	Moderate hunger in household	Severe hunger in household
Malaria	Ref	1.29 (1.03 – 1.63)	3.68 (1.39 – 9.75)
Persistent cough > 2 weeks	Ref	2.38 (1.80 – 3.15)	4.92 (1.76 – 13.74)
Treatment for diarrhea	Ref	1.64 (1.13 – 2.38)	2.55 (0.74 – 8.77)
Treatment for tuberculosis	Ref	2.24 (1.45 – 3.46)	6.06 (1.56 – 23.57)
Hospitalization	Ref	1.95 (1.38 – 2.76)	5.52 (1.78 – 17.16)
Death	Ref	1.14 (0.74 – 1.75)	2.55 (0.68 – 9.49)

socioeconomic stability. Households reporting moderate and severe hunger were more likely to have members who were ill in the recent past. Although further confirmation is required, these results suggest that programs to alleviate food insecurity – especially to those in greatest need – could lead to substantial public health impact.

In this analysis, we studied household hunger as a metric of food insecurity. The HHS – which considers three questions from the nine-item HFIAS – has advantages over the more commonly used HFIAS classification<sup>5</sup>. The HHS was validated using data from six countries, where it performed better than the full HFIAS in different settings<sup>19</sup>. Because the concept of hunger is less subjective and more universally understood, this scale thought to be more reliable for measuring severe food insecurity across cultures. The households identified as having moderate to severe hunger are at the extreme end of the food insecurity spectrum and represent a high-risk population in need of prioritization. There are disadvantages to the metric as well. Because this scale narrowly measures food access, other aspects of food insecurity are not considered; this may limit its usefulness for monitoring broader nutritional trends. There are also few estimates of household hunger for comparison, particularly in urban African settings.

Household hunger correlated with the reporting of several illnesses, including malaria, persistent cough, diarrhea, tuberculosis, and hospitalization. These associations appeared to be independent of potential individual- and household-level confounders, including those related to socioeconomic status. They also appeared to be dose-dependent, as the magnitude of risk increased between moderate and severe hunger. However, it is important to note that, with our cross-sectional design, we were unable to establish causality. It is possible that hunger (and its associated undernourished state) could predispose to illness; it is also logical that illness might contribute to food insecurity as well. At the individual level, this cycle is observed with infection. Malnutrition can lead to increased susceptibility to infection; infection, in

turn, may further contribute to the malnourished state<sup>20</sup>. At the household level, hunger could lead to specific illnesses within household members. At the same time, caring for sick individuals at home could lead to reduced productivity, which in turn could result in greater limitations to food access.

Interestingly, similar associations were not observed with household mortality. This may be related to aspects of our study design. For example, because we reported about deaths in the past 12 months (in contrast to other illnesses, which were reported over the past 3 months), our categorized exposure may not have reflected household hunger at time of the event, especially if food access changed in the interim period. We also observed a similar dose-dependent trend in the associations between household hunger and reported household mortality, suggesting that the study may have been underpowered to observe statistical differences. Larger studies are needed to better understand this potential relationship. Narrower recall windows that place the exposure (i.e., household hunger) closer to outcome (i.e., household mortality) would improve accuracy of reporting, and minimize the misclassification that would bias such analyses towards the null.

Our metric for household hunger relied on self-report and this could lead to potential biases. For example, some may be unwilling to report household hunger because of perceived stigma or discrimination. If respondents believed these answers might lead to tangential benefits – including contemporaneous food supplementation programs that were available in Lusaka at the time<sup>21</sup> – this could lead to an intentional misreporting of household hunger. Respondents may face difficulty in the recall of hunger episodes, particularly if data are not collected longitudinally<sup>22</sup>. Respondent gender and role within the household may also influence perceptions of household hunger. Research by Matheson and McIntyre suggested that, among Canadian households of similar socioeconomic status, women may report higher levels of food insecurity than their male counterparts<sup>23</sup>. If present in our setting, such a bias would be important for our



study, given the high proportion of female respondents (>80%) in our sample.

We acknowledge other limitations. First, the external validity of our findings may not extend to the non-urban settings in Zambia or elsewhere in the region. Second, the rounds of the survey were conducted in the cool and dry season in Zambia; this timing may have affected the availability of harvested food and biased estimates of household hunger. Additional survey responses with seasonal variation would have strengthened our findings. Third, several years have elapsed since this survey study was conducted. It is possible that – with increasing urbanization in Lusaka in the ensuing years – prevalence estimates for household hunger have changed. Given the design of our study, however, this issue of timing may be less relevant for the observed associations between household hunger and key co-morbidities. Fourth, the impact of household hunger likely varies for different members of the household, based on age and health status. For example, food scarcity may affect a child of the HOH differently from the HOH's spouse; vulnerability might not be equal, even in the same household. Due to the nature of data collection, we were unable to stratify health outcomes according to the demographic or medical characteristics of those who fell ill. Finally, a major confounder for health outcomes is the HIV status of household members, including HOH<sup>24</sup>. Unlike more recent community-based surveys in Zambia<sup>17</sup>, HIV testing was not incorporated into our study, making it difficult to separate the effects of HIV infection and hunger on co-morbidities.

## CONCLUSIONS

In this urban African setting, a significant proportion of respondents in a population-based survey reported moderate to severe household hunger. Factors associated with hunger included individual and household characteristics related to socioeconomic status. Importantly, we observed associations between household hunger and reported illnesses, including common conditions such as malaria, diarrhea, and tuberculosis.

Although we recognize limitations in this secondary analysis, our findings suggest that programs designed to improve food access may have a measurable impact on health outcomes at the population level.

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