SLUTRAPPORT/FINAL REPORT
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Henrik Friis & Benedikte Grenov:

MAGNUS – Effekten af mælkeprotein og vallepermeat på lineær vækst, udvikling og tarm blandt børn med væksthæmning

MAGNUS – The effect of milk protein and whey permeate on linear growth, development and gut function among children with stunting

Mejeribrugets
ForskningsFond

Oktober 2024

Final report

for collaborative projects funded via the Danish Dairy Research Foundation (DDRF)

1. Title of the project

De oprindelige titler:

Danish: Mælk og vækst ved moderat underernæring: Betydningen af mælkeprotein og vallepermeat for catch-up vækst hos børn med moderat akut underernæring (MAGMAM)

English: The role of milk protein and whey permeate in catch-up growth of children with moderate acute malnutrition (MAGMAM)

De reviderede titler, efter ændring af studiepopulation fra akut til kronisk underernæring:

Danish: Effekten af mælkeprotein og vallepermeat på lineær vækst, udvikling og tarm blandt børn med vaksthæmning (MAGNUS)

English: The effect of milk protein and whey permeate on linear growth, development and gut function among children with stunting (MAGNUS)

2. Project manager

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4. Sources of funding

Arla Food for Health: 5.87 mio. DKK
Danish Dairy Research Foundation: 1.7 mio. DKK
Nutriset 0.5 mio. DKK
Augustinusfonden 0.5 mio. DKK
Læge Sofus Carl Emil Friis og Hustru Olga Doris Friis' Legat: 0.5 mio. DKK
A. P. Møller Fonden til Lægevidenskabens Fremme: 0.055 mio. DKK

5. Project period

Project period with DDRF funding: January 2018 to December 2020

6. Project summary

Danish:

Formål og metoder

Projektets formål var at undersøge effekten af mælkeprotein og vallepermeat (laktose og vallepermeat) blandt børn med stunting på lineær vækst og kropssammensætning (fedt og fedtfri masse, dvs. muskler og organer), udvikling, tarmfunktion og mikronæringsstofstatus

Studiet blev gennemført omkring byen Jinja ved Nilens udløb fra Victoriasøen i den østlige del af Uganda, i samarbejde med forskere på Makerere Universitet og internationale forskere. I alt deltog 750 børn mellem 1-5 år med *stunting*. Børnene blev ved lodtrækning inddelt i fem grupper af 150. En referencegruppe (på 150) fik ikke noget ernæringstilskud, mens fire grupper (af 150 børn, i alt 600) gennem 12 uger fik et dagligt ernæringstilskud som dækkede op til halvdelen af energi- og proteinbehovet. Ernæringstilskuddet var en fedt-baseret blanding af blendede jordnødder tilsat mælke- eller sojaprotein, vallepermeat eller sukkerstoffet maltodextrin, samt vitaminer og mineraler. Sojaproteinet blev givet som isolat, dvs. sojaprotein af høj kvalitet, hvor mange antinæringsstoffer er fjernet.

Ernæringstilskuddet til børnene i to af de fire grupper indeholdt mælkeprotein med eller uden vallepermeat, mens børnene i de to andre grupper fik ernæringstilskud med sojaprotein med og uden vallepermeat. Det gjorde det muligt at sammenligne de fire grupper, som fik ernæringsstilskud indbyrdes, så vi kunne måle effekten af mælkeprotein i forhold til sojaproteinisolat, og effekten af vallepermeat i forhold til maltodextrin. Desuden ville det være muligt at se den samlede effekt af et ernæringstilskud, uanset mælkeindhold, i forhold til intet tilskud. Børnenes højde og vægt blev løbende målt, og ved starten og slutningen af studiet blev børnenes kropssammensætning og kognitive udvikling målt, og blod- og afføringsprøver blev indsamlet og undersøgt.

Resultater

Effekter af mælkeingredienser

Hverken mælkeprotein (sammenlignet med sojaprotein) eller vallepermeat (sammenlignet med maltodextrin) havde effekter på højdevækst, kropssammensætning, motorisk, sproglig og social udvikling, eller tarmfunktion. Der var derimod en positiv effekt af mælkeprotein på jernstatus, men ikke på B_{12}-vitamin-status. Vi fandt imidlertid, at effekten af vallepermeat på højdevæksten afhang af, om børnene blev ammet. Der var således en statistisk stærk positiv effekt af vallepermeat på højdevækst hos de børn, som fortsat blev ammet, men en negativ effekt hos de børn der ikke længere blev ammet.

Effekter af ernæringstilskud mod referencegruppe

Børnene, som ikke fik noget ernæringstilskud, voksede mindre i højden, end de burde ift. deres alder. Dvs. de blev mere *stuntede* over de 12 uger, studiet varede. Samtidig tog de mere fedtmasse og mindre fedtfri masse på end forventet i forhold til deres højde og alder. Derimod voksede børnene, der fik ernæringstilskud, uanset indholdet af mælkeingredienser, mere i højden end forventet i forhold til deres alder. De ikke bare undgik at blive mere *stuntede*, men de blev mindre *stuntede*, dvs. havde såkaldt *catch-up* vækst. Der var også en effekt på vægten, og det skyldtes fortrinsvis op- bygning af mager kropsmasse.

Konklusion

MAGNUS-studiet viser, at børn i lav-indkomstsamfund, som ikke vokser som de skal, heller ikke i tilstrækkelig grad opbygger muskler og organer, men fedt. Og at ernæringstilskud med mælk eller andet højkvalitet protein samt vitaminer og mineraler, ikke blot kan forhindre yderligere *stunting* og fedtophobning, men også kan få børnene til at indhente noget af det, de er bagefter både med hensyn til højde, muskler og organer.

English:

Aim and methods

The aim of the project was to assess the effects of milk protein and whey permeate (lactose and minerals) in children with stunting on linear growth and body composition (fat and fat-free mass, i.e. muscles and organs), child development, gut function and micronutrient status.

The study was conducted around Jinja city at the source of the Nile from Lake Victoria in eastern Uganda, in collaboration with researchers from Makerere University and international researchers. A total of 750 children between 1-5 years with stunting, i.e. impaired linear growth. The children were randomly allocated to 5 groups of 150. The 150 children in a reference group did not receive any supplement, while the 600 children in the remaining 4 groups (4*150=600) received a daily food supplement for 12 weeks, which covered up to 50% of the daily energy- and protein requirements. The food supplement was a lipid-based blend of peanuts with added milk- or soy protein, whey permeate or the sugar maltodextrin, vitamins and minerals. The soy protein was based on isolate, i.e. soy protein of high quality, with removal of antinutrients.

The food supplement to children in 2 of the 4 groups contained milk protein with and without whey permeate, while the food supplement to children in the 2 other groups contained soy protein with and without whey permeate. This made it possible to compare the 4 groups receiving a food supplement, so that the effect of milk vs. soy protein, and the effect of whey permeate vs. maltodextrin could be estimated. In addition, it would be possible to estimate the effect of food supplements, irrespective of the milk ingredients, compared to no supplement. The height and weight of the children were measured regularly, and at baseline and endline the body composition and development were measured, and blood and stool samples were collected and examined.

Results

The effects of milk ingredients

There were no effects of milk vs soy protein or whey permeate vs maltodextrin on linear growth, body composition, motor/language/social development, or gut function. But there was an effect of milk protein on iron status, but not vitamin B_{12}-status. Surprisingly, we found that the effect of whey permeate depended on whether or not the children were breastfed. Thus, there was a statistically strong effect of whey permeate on linear growth among children still being breastfed, but a negative effect among those that were no longer breastfed.

The effects of food supplement vs no supplement

The children who did not receive any supplement continued to be more stunted over the 12 weeks and gained more fat and less fat-free mass compared to what was expected relative to their age and height. In contrast, children receiving a supplement, independent of the milk ingredients, had more linear growth than expected relative to their age. They not only prevented further stunting but led to catch-up growth. There was also an effect on weight, which was mainly due to accretion of fat-free mass.

Conclusion

The MAGNUS study shows that children in low-income settings who are on a stunting trajectory predominantly gain fat, at the expense of muscle and organs. And that food supplements with milk or other high-quality protein, and vitamins and minerals, not only prevents further stunting and fat accretion, but leads to catch-up growth of not only height but also muscle and organs.

7. Project aim

Danish: At undersøge effekten af mælkeprotein og vallepermeat blandt børn med stunting på lineær vækst og krops-sammensætning, udvikling, tarmfunktion og mikronæringsstofstatus.

English: To assess the effects of milk protein and whey permeate in children with stunting on linear growth and body composition, child development, gut function and micronutrient status.

8. Background for the project (from Pesu H et al., Curr Dev Nutr, 2021)

Globally, 144 million children under the age of 5 y are classified as stunted, having a length- or height-for-age z score (HAZ) of less than −2. Stunting is associated with adverse short- and long-term health outcomes. It is associated with delayed cognitive development, increased morbidity and mortality, poor schooling performance, and later with reduced economic productivity and risk of chronic disease. Stunting also contributes to an intergenerational cycle of malnutrition and poverty, whereby a child born to a stunted mother is more likely to be stunted themselves. In the East African region, close to 1 in 3 children under the age of 5 are stunted. High stunting prevalence is experienced in many low- and middle-income countries and is indicative of exposure to environments of inadequate care, suboptimal nutrition, and recurrent infections. The majority of growth faltering occurs from 3 to 24 mo. of age.

Nutrition interventions to reduce the risk of stunting have therefore focused on prevention through optimizing maternal and early infant nutrition. These interventions, however, have had little impact on linear growth. This was summarized in a recent meta-analysis, whereby complementary feeding interventions, in food-insecure settings, improved HAZ by a mere 0.08 overall. The lack of effect on linear growth has been attributed, at least in part, to environmental enteric dysfunction (EED). The premise is that frequent exposure to pathogens in environments with unsafe water and inadequate sanitation and hygiene (WASH) encourages a state of systemic and intestinal inflammation, as well as morphological and functional changes to the intestine, which can, in turn, exacerbate nutrient deficiencies. However, large trials combining comprehensive WASH interventions with small-quantity lipid-based nutrient supplements (LNS-SQ) reported no effects from the WASH interventions and only minimal effects from the LNS-SQ. While there have been many studies aiming to prevent stunting in young children, or to improve linear growth in wasted children, this is to our knowledge, the first trial which provided large-quantity LNS (LNS-LQ) to children recruited on the basis of stunting. There have been concerns that supplementation in stunted children will lead to excessive accretion of fat rather than lean tissue and therefore increase the subsequent risk of chronic disease. These concerns, however, are not substantiated by the evidence. Recent supplementation studies among children with moderate and severe acute malnutrition have shown that even those who are also stunted predominantly gain fat-free mass. There is a gap in the evidence, however, as to the extent that an LNS-LQ or one containing milk protein (MP) will encourage catchup growth in already stunted children, and to what extent this impacts body composition, mitigates vulnerability to illness, and improves child development and other functional outcomes. However, it is possible that nutritional support to stunted children could have beneficial effects even in the absence of linear catch-up growth. We now know that the co-existence of wasting (low weight-for-height) and linear growth faltering increases a child's risk of morbidity and mortality. Moreover, new evidence from a large 40-y cohort study in The Gambia suggests that stunting not only develops as a chronic condition but also develops interactively with episodes of wasting as a short-term adaptation. Previous nutrition interventions may have been limited by an inadequate supply of energy and high-quality proteins. Considering this, and the recent evidence demonstrating that even short children with wasting predominantly gain fat-free mass, there is sufficient justification to assess the effects of an LNS-LQ among stunted children.

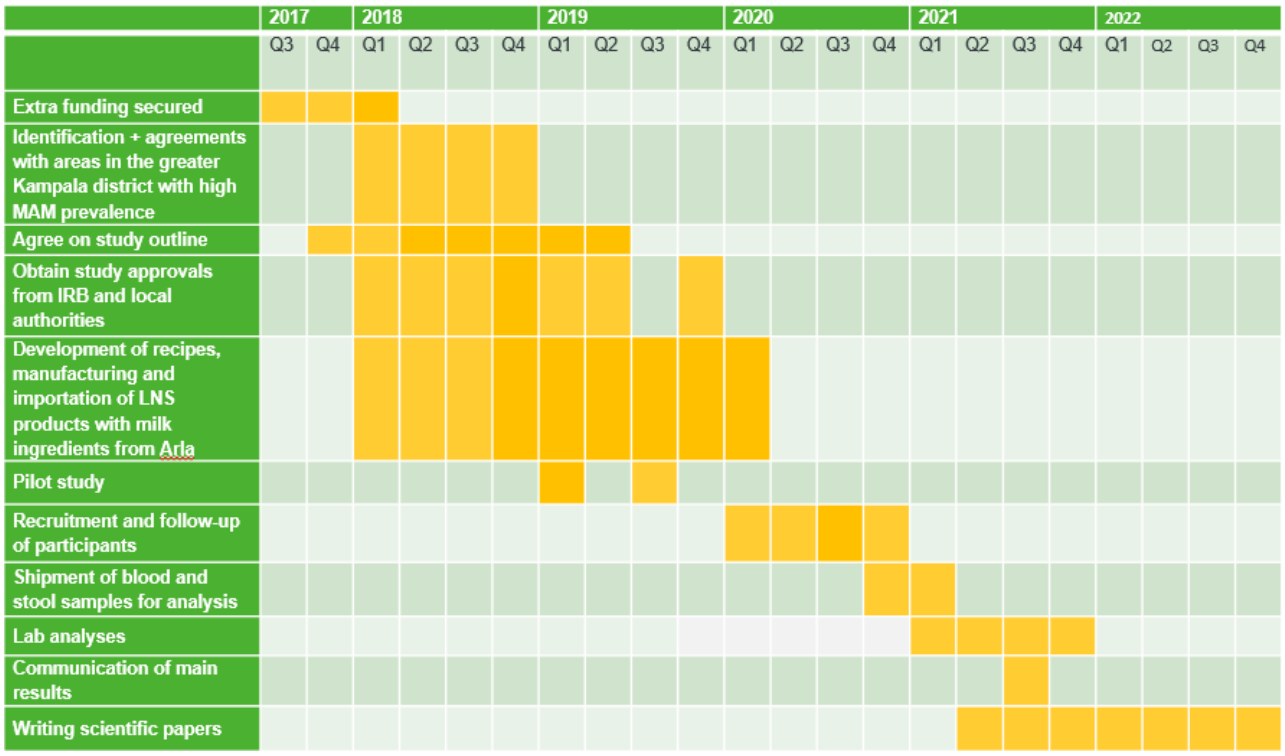
Milk intake has long been associated with linear growth, and it is suggested to have a stronger effect in low-income compared with high-income countries. However, a new review based on studies from predominantly high-income countries could not confirm an effect of milk intake on linear growth. Several studies have shown that the addition of milk in supplements to treat acute malnutrition has had positive effects on body composition, weight gain, recovery, and anemia, but limited or no effect in encouraging linear catch-up growth. In studies from low- and high-income countries, milk intake in children has been associated with improved lean mass deposition, bone-mineral composition, and cognitive function, benefits that may be experienced to a greater extent in children exposed to growth-deficient environments. Furthermore, the different components of milk may provide unique health benefits. MPs have a

complete amino acid profile and are thought to promote growth by stimulating the growth factors insulin-like growth factor-I (IGF-I) and insulin. On the other hand, whey permeate (WP) is predominantly composed of lactose and bioavailable minerals, which may have prebiotic effects as well as a role in bone mineralization and fat-free mass accretion.

In this study, we aimed to assess the individual and combined effects of MP and WP, provided as part of an LNS-LQ, using a 2×2 factorial design, among stunted children. The primary outcome was linear growth. Secondary outcomes were child development, body composition, HAZ, weight-for-age (WAZ), and weight-for-height z scores (WHZ), weight, mid-upper arm circumference (MUAC), head circumference, and hemoglobin. In addition, we assessed the main effect of LNS on these outcomes, irrespective of milk ingredients, as well as the role of the gut as mediator or modifier of effects.

9. Sub-activities in the entire project period

Below the Gantt-chart outlines the time spent on 1) preparations (identification of study sites and agreements; study approval from various authorities and development of food products), 2) pilot study, 3) recruitment and follow-up of participants, 4) shipment and lab-analysis of biological samples, and 5) write-up, which will be ongoing in 2024.



10. Deviations

Explanations of deviations compared with the initial expression of interests:

Scientific: The study was planned to be based on 2–5-year-old children with moderate acute malnutrition, but this was changed to 1-5 year-old children with stunting.

Financial: Partly due to delays but also increased costs, there was a need to raise additional funds from private foundations.

Timetable: The study was delayed due to a number of factors, including the covid-19 pandemic, see Gantt-chart.

11. Project results

Below find a summary of the results with respect to effects on various outcomes: 1) linear growth and body composition, 2) motor/language/social development, and 3) gut function but also assessed the effects on 4) micronutrient status and hemoglobin.

Ad 1) Effects on linear growth and body composition (from Mbabazi et al., Plos Med, 2023)

As reported, 750 (67%) children with stunting between 1-5 y were randomized to the 5 groups of which 736 (98.1%) completed the 12-week follow-up. The median (IQR) age was 30 (23, 41) months, and the mean ±SD HAZ was −3.02 ±0.74, and 12.7% (95) were still breastfed.

Among 150 un-supplemented children, there was a 1.68 (95% CI [1.54, 1.82]; p <0.001) cm increase in height during the 12-week study period, corresponding to a 0.06 (95% CI [0.02, 0.10]; p =0.015) decline in HAZ. Of the 0.58 (95% CI [0.51, 0.64], p <0.001) kg increase in weight, 57.3% (95% CI [53.1, 61.4]) was FFM. To account for the increase in height, the increase in body mass was also indexed for height. Accordingly, there was a 0.29 (95% CI [0.20, 0.39], p < 0.001) kg/m2 increase in FMI, but a 0.06 (95% CI [−0.002, 0.12]; p =0.057) kg/m2 decline in FFMI.

In the primary analysis, we estimated the effects of MP and WP among the 600 children receiving LNS. There were no interaction between MP and WP, and no effects of either MP or WP on the primary outcomes: milk vs soy protein was associated with a 0.03 (95% CI [−0.10, 0.16]; p=0.662) cm increase in height and a 0.2 (95% CI [−0.3, 0.7]; p=0.389) mm increase in knee-heel length. For WP vs maltodextrin, the corresponding estimates were −0.08 (95% CI [−0.21, 0.05]; p=0.220) cm and −0.20 (95% CI [−0.67, 0.27], p=0.403) mm. MP was associated with an insignificant 0.06 (95% CI [−0.002, 0.12]) kg/m2 greater increase in FFMI. There were no effects on other anthropometric outcomes, body composition, or on serum IGF-1.

The effects of WP on linear growth were modified by breastfeeding, due to positive effects of WP on linear growth among breastfed, but negative effects among non-breastfed children. As such, WP increased height by 0.44 (95% CI [0.08, 0.81]; p=0.017) cm in breastfed, but reduced it by 0.16 (95% CI [0.02, 0.30]; p=0.025) cm in non-breastfed children (interaction p=0.003). Similarly, WP increased knee-heel length by 1.3 mm (95% CI [0.01, 2.7]; p=0.049) in breast-fed children, but not among non-breastfed (−0.4 mm, 95% CI [−0.9, 0.1]; p=0.095, interaction, p=0.016).

In the secondary analysis, LNS, irrespective of milk ingredients, resulted in a 0.56 (95% CI [0.42, 0.70]; p<0.001) cm increase in height and 1.9 (95% CI [1.4, 2.4], p<0.001) mm increase in knee-heel length. The effect on height corresponded to a 0.17 (95% CI [0.13, 0.21]; p<0.001) increase in HAZ, which was not different in children below and above 2 years of age (0.19 versus 0.16, p=0.555). LNS resulted in 0.21 (95% CI [0.14, 0.28]; p < 0.001) kg larger weight gain, accompanied by 0.08 (95% CI [0.01, 0.16], p=0.035) increase in WHZ. The 0.21 kg increase in weight was driven by FFM gain (0.16 kg, 95% CI [0.11, 0.22]; p<0.001) rather than FM (0.04 kg, 95% CI [−0.03, 0.12]; p=0.250). Hence, FFM
comprised 76.5% (95% CI [61.9, 91.1]) of the weight gained due to LNS supplementation. When expressed as height-adjusted indices, the effect of LNS was largely due to an increase in FFMI (0.07 kg/m2,95% CI [0.0001, 0.13]; p=0.049), rather than FMI (0.01 kg/m2,95% CI [−0.10, 0.12]; p=0.800).

2) Effect on motor/language/social development (from Mbabzi et al., Nutrients 2023)

As reported, child development was assessed using the Malawi Development Assessment Tool. Data were analyzed using linear mixed-effects models. There were no interactions between MP and WP for any of the outcomes. There was no effect of either MP or WP on any developmental domain. Although LNS itself had no impact on development, it resulted in 0.07 cm (95%CI: 0.004; 0.14) higher head circumference. In conclusion, neither dairy in LNS, nor LNS in itself, had an effect on development among already stunted children.

3) Effects on gut function (from Pesu et al., submitted, 2023)

In this study, the outcome was plasma citrulline, a marker of enterocyte mass or absorptive capacity. Neither MP nor WP had any main effect on plasma citrulline, but MP was associated with a 4.69 (95%CI: 0.88; 8.50) µmol/L greater increase in plasma citrulline for girls. LNS, irrespective of milk ingredients, had no effect on plasma citrulline.

Interestingly, low plasma citrulline reduced the effect of LNS on improvement in B_{12}-status.

4) Effects on micronutrient status (from Mutumba et al., submitted, 2023)

In this study, the outcomes were markers of iron status (serum ferritin and soluble transferrin receptor), as well as of vitamin A (retinol binding protein), B_{12} (plasma cobalamin and methylmalonic acid) and folate (plasma folate) status. MP was associated with a 14% (95% CI 3; 26) greater increase in iron stores (serum ferritin, corrected for inflammation) compared to soy protein. There were no other effects of either MP or WP.

12. The relevance of the results, including relevance for the dairy industry

We didn't detect any main effects of milk protein and whey permeate on linear growth, or on child development and gut health. The effect of milk protein was assessed based on comparison to another high-quality protein, soy isolate. Subgroup analysis showed a statistically strong interaction between whey permeate and breastfeeding status with respect to all linear growth outcomes, i.e. total height, knee-heel height and HAZ. In other words, the effect of whey permeate on linear growth was modified by whether or not the children were still being breastfed. So, the lack of a main effect reflected a positive effect on linear growth among children still being breastfed, and a negative effect among children that were no longer breastfed.

Our results showed that children with stunting gained fat mass and continued a stunting trajectory if they were not treated with any food supplement. In contrast, supplementation with LNS (irrespective of milk ingredients) resulted in catch-up of both linear growth and lean body mass. These results are new, important and may influence the current recommendations not to treat children with stunting.

In the MAGNUS study we compared milk protein concentrate against soy protein isolate. Both are highly processed ingredients and proteins of very high quality. There is still a need to explore the importance of milk in food supplements and therapeutic foods for different groups of malnourished children. In addition, it could be relevant to investigate the effect of milk as a relatively accessible source of animal protein in home-based diets for children from low- income settings where both stunting and infections are prevalent. Both stunting and infections contribute to an increased demand for essential amino acids/high quality protein in order to catch up in growth and to combat infections. This may be difficult to achieve in low-income settings where the basic diet is often of very low nutritious quality.

Finally, the positive effect of milk protein on iron status is interesting as MFF is currently funding another project: Mineral Milk at Aarhus University, looking into the effects of milk protein on uptake of iron, zinc and magnesium through a range of *in vitro* studies. Our results confirm that this may be possible *in vivo.*

13. Communication and knowledge sharing about the project

Papers in international journals:

1. Lewis, J. I., Friis, H., Mupere, E., Wells, J. C. & Grenov, B. Calibration of Bioelectrical Impedance Analysis Against Deuterium Dilution for Body Composition Assessment in Stunted Ugandan Children. The Journal of Nutrition 153, 426–434 (2023).
2. Mbabazi, J. et al. Effect of milk protein and whey permeate in large quantity lipid-based nutrient supplement on linear growth and body composition among stunted children: A randomized 2 × 2 factorial trial in Uganda. PLoS Med 20, e1004227 (2023).
3. Mbabazi, J. et al. Effect of Milk Protein and Whey Permeate in Large-Quantity Lipid-Based Nutrient Supplement on Early Child Development among Children with Stunting: A Randomized 2 × 2 Factorial Trial in Uganda. Nutrients 15, 2659 (2023).
4. Mutumba, R. et al. Micronutrient Status and Other Correlates of Hemoglobin among Children with Stunting: A Cross-Sectional Study in Uganda. Nutrients 15, 3785 (2023).
5. Mutumba, R. et al. Correlates of Iron, Cobalamin, Folate, and Vitamin A Status among Stunted Children: A Cross-Sectional Study in Uganda. Nutrients 15, 3429 (2023).
6. Pesu, H. et al. The Role of Milk Protein and Whey Permeate in Lipid-based Nutrient Supplements on the Growth and

Development of Stunted Children in Uganda: A Randomized Trial Protocol (MAGNUS). Curr Dev Nutr 5, nzab067 (2021).

Several manuscripts are under preparation or submitted.

Easily read papers:

1. Press release about MAGNUS main findings. University of Copenhagen, 2023
2. Grenov B, Mølgaard C, Michaelsen KF, Friis H. Mælk og kronisk underernæring: Forskningsprojektet MAGNUS har undersøgt effekterne af mælkeprotein og vallepermeat på børn med hæmmet højdevækst i Uganda. (Sendt til AFH mhp publikation)

Student theses:

Lewis J: Correlates of body composition in stunted Ugandan children using bioelectrical impedance analysis. UCPH, 2020 [MAGNUS-data]
Kamugisha J: Ponderal and linear growth in malnourished children. UCPH, 2022 [Partly MAGNUS-data]
Pesu H. *The gut in childhood stunting: a randomised trial in Uganda*, UCPH, 2023 [MAGNUS-data]
Oral presentations at scientific conferences, symposiums etc. (incl planned):

1. Hannah Pesu: The MAGMAM study; oral presentation at the Rank-Prize Mini-Symposium on Malnutrition Through the Life Course, 16th to 19th July 2018, Grasmere, UK
2. Friis H et al. Presentation of preliminary data at the AFH-seminar
3. Mbabazi J & Mutumba R presented preliminary data at the Pediatric Department, Rigshospitalet, 10 November 2021.
4. Mbabazi J presented main findings at the University of Copenhagen Association of PhDs Late-night PhD Talk Show.
5. Grenov B. Effect of milk protein and whey permeate in large-quantity lipid-based nutrient supplement on linear growth and body composition among children with stunting: a randomised 2x2 factorial trial in Uganda. International Conference on Nutrition & Growth, London, March 2023.
6. Mutumba R. The effect of LNS with and without milk protein and whey permeate on haemoglobin and iron, vitamin A and B status among children with stunting: a RCT in Uganda. Abstract submitted for presentation at Micronutrient Forum 6th Global Conference, Hague, The Netherlands, 16-20 October 2023.
7. Mutumba R. Correlates of micronutrients and hemoglobin among stunted children: a cross-sectional study in Uganda. Abstract submitted for presentation at Micronutrient Forum 6th Global Conference, Hague, The Netherlands, 16-20 October 2023.
8. 5th federation of African Nutrition Societies (FANUS) conference due to take place from 19-24 November 2023 in Dakar, Senegal.

Other: Interview with Benedikte Grenov in DR P1 Morgen.

14. Contribution to master and PhD education

4 (3+½+½) PhD and 1 MSc:

3 PhD-students have based their entire PhD on data from the MAGNUS study. Of these, 1 was Danish and fully registered at UCPH, and completed her defense in June 2023. The other 2 were Ugandan, with host registration at Makerere University and partner/double-degree registration at UCPH. A student from UK did his master thesis based on MAGNUS data and used data from MAGNUS for one of his papers in his PhD thesis.

15. New contacts/projects

Based on material from MAGNUS, funding was obtained for the Microgam-project, see separate report.

We currently search for funding to allow follow-up of the children included in the MAGNUS-trial, i.e. MAGNUS-2, to assess the effect of supplementation and fat mass on cardio-metabolic risk markers.