Appendix I

Ethical Approval to conduct the Study

Independent Ethics Committee (IEC), Navi Mumbai

Chairperson
Mr. J.C. Sharma
(9892021899)

Member Secretary
Dr. Neeraj Ravani
(9830325628)

Address for Correspondence
Ground floor, Plot No. 226
Sector 2, Vashi, Navi Mumbai
Telephone/Fax: 022 27820464
E-mail: iecnavimumbai@gmail.com

IEC No. 0971C

PROJECT APPROVAL LETTER

Name of the EC - Independent Ethics Committee Navi Mumbai

Address of Ethics Committee – Ground floor, plot no 226, sector-2, Vashi, Navi Mumbai - 400703

Principal Investigator: Ms. Minavindra Savanur
Institutional address: Department of Food Science & Nutrition, SNDT Women’s University, Juhu Campus, Santacruz (W), Mumbai -49.

Clinical trial protocol title: “Nutritional status and cognitive functions of children aged 2-4 years vis-a-vis their birth weight”

The Independent Ethics Committee Navi Mumbai has reviewed the following documents submitted for the above-mentioned clinical study.

<table>
<thead>
<tr>
<th>Name of document</th>
<th>RV</th>
<th>AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protocol</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>2. English Questionnaire</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3. Parents Information Sheet for Nutritional status assessment</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>4. Parents Information Sheet for Assessment of Cognitive Functions</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>5. English Informed consent form</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

RV denotes Reviewed; AP denotes Approved. Y = yes; N = no

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Members: Dr. Pramila Yadav, Adv. Nilesh Bhojne, Fr. Thomas Varghese, Dr. Surajit Asekar, Mr. M.P. Mulla, Mr. Ganesh Devkar, Dr. Akshaykumar Chhailani, Dr. Sukirti Jain, Dr. V.V. Krishnan, Dr. Sudhir Sharma
PROJECT APPROVAL LETTER

The approval for the study has been granted and the study can be initiated at the specified trial site on 01\textsuperscript{st} Dec 2012.

The research proponents are hereby informed that the Independent Ethics Committee (IEC) will require the following:

1. All adverse events that are either serious or unexpected to be reported within 7 working days to the IEC. If SAE is death it must be reported within 24 hours.
2. The progress report to be submitted to the IEC at least annually. In the absence of receipt of the same by courier (13 months from the approval date) the IEC may revoke the permission to conduct the study.
3. Upon completion/premature termination of the study, a final study status report including summary of results needs to be submitted to the IEC.
4. All protocol deviations /changes in the protocol must be informed to the IEC in writing and notification / approval from the IEC must be taken. No change in the protocol (amendment) must be implemented without approval of the IEC.
5. The PI must promptly report the following to the IEC:
   a) Any 'new information' acquired during the course of the trial that may adversely affect the safety of the subject
   b) Any 'change' in the protocol that will increase the existing risk /subject the research participants to new risks during the course of the trial
6. The PI must ensure all required regulatory/administrative approvals are taken before execution of the trial.
7. You are also requested to follow Ethical aspects of the clinical trial as described in the booklet ‘Ethical Guidelines for Biomedical Research on Human Participants, ICMR 2006’

In the above circumstances measures taken by the PI to protect the research participants and eliminate hazards must be specified

DECISION

<table>
<thead>
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<tbody>
<tr>
<td>The above mentioned study was approved by the IEC Navi Mumbai at the meeting held on 01\textsuperscript{st} Dec 2012.</td>
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</tbody>
</table>

**Independent Ethics Committee, Navi Mumbai**

Date of approval: 01/12/2012

Mr. J.C. Sharma
Chairperson
Appendix II

Information Sheet for the Parents for Nutritional Status Assessment

Protocol Title: Nutritional Status and Cognitive Functions of Children aged 2 – 4 years vis-à-vis their Birth Weight

Introduction: This is a subject information sheet, which provides all the relevant details of this research study. Before you decide that your child participates in it, it is important for you to understand why this research is being carried out. It explains the nature, the purpose, the benefits, the discomforts and conduct of the study. This sheet may contain certain scientific terms and if there is anything that is not clear to you or if you want more information, please ask any of study personnel or contact persons mentioned below, before you give your consent and also anytime during the entire course of study.

For your safety or any study related queries, please contact:
Ms Mitravinda Savanur (Principal Investigator) – 9920150352

For your Rights and Safety, please contact:
Mr. J. C. Sharma (Chairperson of IEC)

Study Centre: Anganwadis under the ICDS in Mumbai

Purpose of the Study: The first two years of life is a critical period for growth and development of every child. A number of factors including birth weight influences the nutritional status and body composition of the child during this period. On one hand, findings from recent studies suggest that those born with lower birth weights tend to gain more body fat than lean mass. This makes them more vulnerable to non communicable diseases like type 2 diabetes and cardiovascular diseases early in life. On the other hand, birth weight influences their cognitive development. Fewer studies have been conducted in this area in a developing country like India where, the prevalence of low birth weight is high. Keeping this in mind, the present study is being undertaken.

How many children will take part in the study?
1200 children aged 2 – 4 years will be enrolled for the study.

What is the procedure that my child has to undergo?
You or any parent will be interviewed for details about the family’s ethnic background, education, occupation. Your child’s date of birth and birth weight will be taken from the records. The following measurements of your child will be taken –

- Weight – using an electronic weighing scale
- Height – using a measuring tape
• Circumferences of the following sites – head, upper arm, waist and hip – using a measuring tape
• Skinfold thickness of the following sites – upper arm, back and near the naval region.

Skinfold thickness will be measured by a calliper as shown in the figure.

• All the measurements will be taken in triplicates.

**Will my child’s participation in the study be confidential? Who will have access to my data?**
Your child’s participation and data will be kept confidential. Your child’s data will be used for research purpose only. If you desire, your child’s data will be shared with you.

**What will be done with my child’s data?**
Your child’s data will be used for research purpose only to fulfil the purpose of the study (as described earlier).

**What is Independent Ethics committee (IEC)?**
IEC is an independent voluntary body, whose chief objective is to safeguard the rights, the safety and well being of the study patients. It also approves and monitors the conduct of study. It is no way related to the sponsor or investigator of the study. It consist of members such as doctors, social worker, legal expert and lay person.IEC gives approval only after ensuring the adequate safety of patient during the study.
INFORMED CONSENT FORM

Parent's Name: ______________________       Child’s Name: ____________

(Full name in BLOCK CAPITALS)

Child’s Date of Birth: _______________       Parent’s Initials: ____________

By signing below, I show that:

(i) I confirm that I have read and understood the information mentioned in this Information Sheet for Parents. I have received an explanation of the nature, purpose, duration, and foreseeable effects and risks of the study and what my child will be expected to do and have had the opportunity to ask questions. All of my questions were answered to my satisfaction.

(ii) I understand that my child’s participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

(v) I have had time to make my decision whether or not to take part in this research. I agree to take part in the research study described in this form. I will receive a signed and dated copy of this form for my records.
Statement of Person Obtaining Informed Consent

I, the undersigned, have fully explained the details of this clinical study as described in this Patient Information Sheet and Informed Consent Form to the patient named above.

________________________________________________
Name of Person Obtaining Informed Consent:
(Full name in BLOCK CAPITALS)

Signature __________________________________ Date ________________

Signature of Person Obtaining Informed Consent

Witness Signature (if applicable)

________________________________________________
Name of Witness:
(Full name in BLOCK CAPITALS)

Signature __________________________________ Date ________________

Signature of Witness

[A witness signs (i) in addition to the parent if the Information Sheet for the Parent and Informed Consent Form are read to the parent, or (ii) in lieu of the parent for parents who are legally capable of providing consent but unable to read or write.]
पोषण स्तर पर होनेवाले संशोधन का महत्त्वपूर्ण पत्रक

शीर्षक: 2 से 4 वर्ष के बालकों के पोषण स्तर और बौद्धिक क्षमता पे उनके जन्म के समय रहे वजन का प्रभाव

परिचय: ये पत्रक संशोधन के बारे में सारी जानकारी देता है। आपके बच्चे को इस संशोधन में भाग लेने की अनुमति देने से पहले, आपको इस संशोधन के बारे में जानना जरूरी है। इस पत्रक में संशोधन के उद्देश्य, उनके फायदे और नुकसान के बारे में समझाया गया है। आगर कोई तकनीकी शब्द का उपयोग इस पत्रक में हो और वह आपको समझ में नहीं आये, तो आप इसके बारे में सम्बन्धित अधिकारी से पूछ सकते हैं। शोधकर्ता का नाम और दृश्यात्मक क्रमानुसार नीचे दिए गए हैं।

संशोधन के बारे में कोई भी सवाल हो तो कृपया नीचे दिए गए व्यक्ति से संपर्क करे

मित्रविदा सञ्चार (मुख्य शोधकर्ता) - ९९२०१५०३५२

अपने अधिकारों तथा सुरक्षा के लिए कृपया नीचे दिए गए व्यक्ति से संपर्क करे

श्री जे. सी. शमाज (अध्यक्ष, आ. ई. सी)

परीक्षण का स्थल: मुंबई में स्तंभ आंगनवाड़ी केंद्र

संशोधन का हेतु: जीवन के पहले दो वर्ष बच्चे के संपूर्ण विकास के लिए अत्यंत महत्त्वपूर्ण होते हैं। इस दौरान, बच्चे का पोषण और विकास भूमि में सारी विषयों पर निर्भर करता है। इन में, जन्म के समय बच्चे का वजन बहुत महत्त्वपूर्ण है। हालांकि किसे जाये शादी के अनुसार, जीन बच्चों का जन्म के समय वजन कम होता है, उनमें मास- पेट्रेक के बजाय चब्बी की मात्रा ज्यादा पायी जाई है। इससे उन्हें मधुमेह, हदता रोग जैसी बौद्धिकीय क्रियाओं का खतरा ज्यादा होता है। इस के साथ ही, उनके बौद्धिक विकास पर भी असर हो सकता है। हमारे देश में इस प्रकार के संशोधन कम हुए हैं। भारत में कई बच्चों का जन्म के समय वजन कम पाया गया है। इन विषयों को ध्यान में रखते हुए, यह संशोधन किया जाने वाला है।

कितने बच्चे भाग लेंगे?

2 से 4 वर्ष के १२०० बच्चे भाग लेंगे।
इस परीक्षण के लिए मेरे बच्चे को क्या करना होगा?
हम आप से आपके परिवार के सदस्यों के शिक्षण, रोजगार के विषय जानकारी प्राप्त करेंगे। अंगनवाड़ी से आपके बच्चे की जन्म तारीख और जन्म के समय के वजन की जानकारी ली जाएगी। साथ ही, आपके बच्चे के निम्नलिखित माप लिए जायेंगे -
वजन - डिजिटल वजन कोंडे का उपयोग किया जायेगा
ऊँची - माप लेने वाले टेप का इस्तेमाल किया जायेगा
नाप - सिर, बांह और कमर का माप टेप से लिया जायेगा

शरीर की चर्बी ४ जगहों पर एक कैलिपर द्वारा मापा जायेगा।
सरे माप 3 बार लिए जायेंगे।
क्या मेरे बच्चे से ली गयी जानकारी गुप्त राखी जाएगी? इस जानकारी की किसके पास रहेगी?
आप के बच्चे से ली गयी जानकारी गुप्त राखी जाएगी। जानकारी का उपयोग केवल संशोधन के कार्य के लिए होगा।
अगर आप चाहें तो, हम आप के बच्चे से ली गयी जानकारी आपको उपलब्ध की जाएगी।
मेरे बच्चे से प्राप्त जानकारी का उपयोग कैसे होगा?
आपके बच्चे से प्राप्त जानकारी का उपयोग केवल संशोधन हेतु को पूरा करने के लिए किया जायेगा।
संस्करण पत्रक

चचें का नाम ___________________________ जन्म तारीख ____________________

माता / पिता का नाम और स्वाक्षर __________________________

में स्वाक्षर करके बताती हूँ की नीचे दी गई सूचना________________________

1) मे ने सब सूचना पढ़ी है और मे यह सब समझ गई है। उसके बारे मे सब एक्ट बताया गया है। युक्त प्रथम पूछने की संस्करण दी धी और प्रणों के उत्तर दिये गये हैं।

2) मैं समझ गई हूँ की इस संगठनमें मेरे बच्चे को शामिल करना या न करना सीधे मे तय करेगी। अगर मेरे मेरे बच्चे का नाम निकालना होगा तो मैं जब चाहे वहा कर सक्तीगी।

3) मैं समझती हूँ के व्यवस्था नीति/मान्यता संस्था या कोई अन्य संबंधित अधिकारी व्यक्तियों मेरे बच्चे की आयुष्य की जानकारी देने के लिए मेरी संस्करण की जासूसी नहीं रोगी। अगर मैं मेरे बच्चे का नाम निकालना होगा तो मैं यह जानकारी देने के लिए मेरी संस्करण की जासूसी नहीं। सीधे मेरे बच्चे का नाम किसीको न कहा जाए और कही कही ना जाए।

4) इस संस्करण की बजह से मिली हुई आयुष्य की जानकारी का उपयोग करने पर कोई आपत्ति की जाने हुई है, अगर इसका उपयोग केवल संस्करण के काम के लिए होगा।

5) इस संगठनमें मेरे बच्चे को सामिल करने के लिए मुझे सोचने का आपदा वक्त दिया गया था। मेरे बच्चे को इस संगठनमें सामिल करने के लिए मैं लगात रहूँ। मुझे एक स्वाक्षर और लिखक कही हुई कार्य दी जाएगी।

स्वाक्षर करना ____________

जिन व्यक्ति से संस्करण ली उसका विचार

मे नीचे स्वाक्षर की हुई व्यक्ति कहती हूँ की संगठन के बारे मे सब जानकारी जो इस संगठनमें बच्चे को शामिल करना उसे हृदयः।

संस्करण देने वाले व्यक्ति का नाम
संस्करण देने वाले व्यक्ति के हस्ताक्षर ____________

साक्षीदार का नाम
साक्षीदार के हस्ताक्षर ____________

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पोषण स्थर व बोधनात्मक विकासकर्त्या होणार्या संशोधनाबद्दल माहिती पत्रक

शीर्षक: २ ते ४ वयोगटाच्या मुलांचे पोषण स्थर व बोधनात्मक क्षमतेचे व त्याच्या जन्मतः असलेल्या वजनावर तुलनात्मक परीक्षण

प्रस्तावना: हे पत्रक या संशोधनाबद्दल सर्व माहिती देते. तुमच्या मुलाच्या जन्माच्या वेळेस ज्या मुलांना ज्या संशोधनाच्या उद्देश्याने प्रयोग केलेल्या असलेल्या वजनाचे तुलनात्मक परीक्षण करून घेते. हा प्रकरण तेथे शासक शक्ति है वैज्ञानिक विषयासाठी सर्वांना वापरले जाऊ शकतो.

संशोधनाबद्दल काही प्रश्न असल्यास संपादक आहेत.

मित्रविदा सांगुर (प्रमुख संशोधक) - १९२०९५३५२

आपले अधिकार व सुरक्षिततेचे संदर्भात प्राप्त असल्यास हाती त्याचे संपर्क संपर्क करावा आहे.

श्री. जे. सी. शमाष (अध्यक्ष, आय.इ.सी.)

परीक्षण स्थल- मुंबईतील आंगणवाडी केंद्रे

संशोधनाचा हेतु - प्रयोग करणाऱ्यांना आपल्याला माहितीप्रदेश देणाऱ्या दोन वर्षांमध्ये होत अतीताचे महत्त्वाचे असतात. मुलांच्या पोषण स्थाराच्या अनेक गोष्टींचा प्रभाव पडतो. असे पाहण्यासाठी हा पत्रक वापर करू शकतो, त्याच्या अंतर्गत वाचकांना प्राप्त दुसरी विविध प्रभाव जास्त असेल. त्यामुळे, अशा मुलांमध्ये मधुमेह अथवा हृदय संबंधीत आजार नाहीत, त्यामुळे मुलांच्या भागातील अतिशय महत्त्वाचे असते. ज्यामाहित, अनेक गोष्टींचा प्रभाव पडतो. त्यामुळे, अशा मुलांमध्ये मधुमेह अथवा हृदय संबंधीत आजार नाहीत, त्यामुळे मुलांच्या भागातील अतिशय महत्त्वाचे असते.

ह्या परीक्षणांत फक्त मुले भाग घेतील?

२ - ४ वर्षोपर्यंत निवडले जातील.

ह्या परीक्षणांत फक्त मुले भाग घेतील?
मुलाची उंची, वजन व दंडाचे, डोक्याचे व कंबरेचे घेतले जाल. ह्या सर्वसाधारण वजनचा काठ व माप घेण्याची पडी वापरली जाल. जाडी मोजण्यासाठी केलिपर वापरले जाल. ह्या पद्धतीत दंड, पाठ आणि पोटावर बेंबी जवळ एकच चिमटीत ल्याचा उचलली जाल आणि केलिपरी त्याचे माप घेतले जाल.

माझ्या मुलाचा सहभाग गुप्त ठेवल्या जाल का? ती सर्व माहिती कोण असेल?
या संशोधनात तुमच्या मुलाचा सहभाग व सर्व माहिती गुप्त ठेवण्यात येईल. सर्व माहिती फक्त संशोधक व संबंधित लोकांनाच दाखवली जाल.

माझ्या मुलाची जी माहिती घेतली आहे, त्याचे काय केले जाल?
या माहितीचा वापर संशोधनसाधीव केला जाल. तुमच्या इच्छा असत्यास तुम्हाला मुलाची सर्व माहिती दिली जाल.

स्वतंत्र नितीमत्ता मंडळ करणारी संस्था म्हणजे काय?
आय. इ. सी. ही एक स्वतंत्र नितीमत्ता मंडळ संस्था आहे. त्यांचे उद्देश्य आहे की संशोधनात भाग घेणाव्या व्यक्तीमध्ये कायदेशीर सर्व हक्क सांभाळले जातील. ही संस्था संशोधनसाधी त्याच्यात पात्र ठरवते व त्या संशोधकवर लक्ष्य हे ठेवते. ह्या संस्थेचा संशोधन कार्याची काही संबंध नाही. ह्या संस्थेच संभासद खालील आदर्शीय व्यक्ती आहे - डॉक्टर, सामाजिक कार्यकर्ता, कायदाचे तज्ज्वत आणि सामान्य माणूस. ही संस्था परवानगी देण्या आही सर्व खात्री करून पेते.
विचारपूर्वक संगठन प्रण

मुख्य नाम ___________________________ जन्म तारिख ___________________________

पालक/धारक नाम व माही ___________________________

साक्षीदार नाम व सही ___________________________

तारीख ___________________________

साक्षीदाराचे नाव ____________________________________________________________________

साक्षीदाराची सही ____________________________________________________________________

तारीख ___________________________

वर्तमान साक्षीदाराचे नाव ____________________________________________________________________

साक्षीदाराची सही ____________________________________________________________________

तारीख ___________________________

संहार साधित झालेय-या व्यक्तिवर्गीय माहितीनुसार वापर आहे येवनाही नाही, तर ते फक्त शाखातून कामाचारी असेल.

संहार साधित झालेय-या व्यक्तिवर्गीय माहितीनुसार वापर आहे येवनाही नाही, तर ते फक्त शाखातून कामाचारी असेल.

3) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

4) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

5) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

6) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

7) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

8) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

9) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

10) माहिती किंवा साक्षीदाराचा नाव असा तर ते फक्त शाखातून कामाचारी असेल.

संहार साधित झालेय-या व्यक्तिवर्गीय माहितीनुसार वापर आहे येवनाही नाही, तर ते फक्त शाखातून कामाचारी असेल.

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संहार साधित झालेय-या व्यक्तिवर्गीय माहितीनुसार वापर आहे येवनाही नाही, तर ते फक्त शाखातून कामाचारी असेल.
Appendix III

Information Sheet for the Parents for Assessment of Cognitive Functions

Protocol Title: Nutritional Status and Cognitive Functions of Children aged 2 – 4 years vis-à-vis their Birth Weight

Introduction: This is a subject information sheet, which provides all the relevant details of this research study. Before you decide that your child participates in it, it is important for you to understand why this research is being carried out. It explains the nature, the purpose, the benefits, the discomforts and conduct of the study. This sheet may contain certain scientific terms and if there is anything that is not clear to you or if you want more information, please ask any of study personnel or contact persons mentioned below, before you give your consent and also anytime during the entire course of study.

For your safety or any study related queries, please contact:
Ms Mitravinda Savanur (Principal Investigator) – 9920150352

For your Rights and Safety, please contact:
Mr. J. C. Sharma (Chairperson of IEC)

Study Centre: Anganwadis under the ICDS in Mumbai

Purpose of the Study: The first two years of life is a critical period for growth and development of every child. A number of factors including birth weight influences the nutritional status and body composition of the child during this period. On one hand, findings from recent studies suggest that those born with lower birth weights tend to gain more body fat than lean mass. This makes them more vulnerable to non communicable diseases like type 2 diabetes and cardiovascular diseases early in life. On the other hand, birth weight influences their cognitive development. Fewer studies have been conducted in this area in a developing country like India where, the prevalence of low birth weight is high. Keeping this in mind, the present study is being undertaken.

How many children will take part in the study?
From the children who participated in the ‘Nutritional Status Assessment’ around 120 – 150 children aged 3 – 4 years will be enrolled for the study.

What is the procedure that my child has to undergo?
Your child will be asked to perform certain tasks –

1. A board with ten wooden blocks of different shapes will be given. Your child will be instructed to place the varied shaped blocks in their corresponding recesses on the board as fast as possible.

2. He/she will be given a pencil and different mazes. He/she will be instructed to draw between the two black lines of the mazes without touching them.
3. Some coloured blocks of varying sizes and shapes will be provided to your child. He/she will be expected to arrange the blocks that look alike in groups.
4. Pictures will be shown to your child. He/she will be expected to recall/recognise them.

**Will my child’s participation in the study be confidential? Who will have access to my data?**
Your child’s participation and data will be kept confidential. Your child’s data will be used for research purpose only. If you desire, your child’s data will be shared with you.

**What will be done with my child’s data?**
Your child’s data will be used for research purpose only to fulfil the purpose of the study (as described earlier).

**What is Independent Ethics committee (IEC)?**
IEC is an independent voluntary body, whose chief objective is to safeguard the rights, the safety and well being of the study patients. It also approves and monitors the conduct of study. It is no way related to the sponsor or investigator of the study. It consist of members such as doctors, social worker, legal expert and lay person. IEC gives approval only after ensuring the adequate safety of patient during the study.
INFORMED CONSENT FORM

Parent's Name:_______________________  Child’s Name:_______________________
(Full name in BLOCK CAPITALS)
Child’s Date of Birth: _______________  Parent’s Initials: __________

By signing below, I show that:

(i) I confirm that I have read and understood the information mentioned in this Information Sheet for Parents. I have received an explanation of the nature, purpose, duration, and foreseeable effects and risks of the study and what my child will be expected to do and have had the opportunity to ask questions. All of my questions were answered to my satisfaction. [ ]

(ii) I understand that my child’s participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. [ ]

(iii) I understand that the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published. [ ]

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). [ ]

(v) I have had time to make my decision whether or not to take part in this research. I agree to take part in the research study described in this form. I will receive a signed and dated copy of this form for my records. [ ]
Statement of Person Obtaining Informed Consent

I, the undersigned, have fully explained the details of this clinical study as described in this Patient Information Sheet and Informed Consent Form to the patient named above.

________________________________________________
Name of Person Obtaining Informed Consent:
(Full name in BLOCK CAPITALS)

Signature __________________________________ Date

________________________________________________
Signature of Person Obtaining Informed Consent

Witness Signature (if applicable)

________________________________________________
Name of Witness:
(Full name in BLOCK CAPITALS)

Signature __________________________________ Date

________________________________________________
Signature of Witness

[A witness signs (i) in addition to the parent if the Information Sheet for the Parent and Informed Consent Form are read to the parent, or (ii) in lieu of the parent for parents who are legally capable of providing consent but unable to read or write.]
बौद्धिक क्षमता पर होनेवाले संशोधन का महत्त्वपूर्ण पत्रक

शीर्षक: 2 से 4 वर्ष के बालकों के पोषण स्तर और बौद्धिक क्षमता पे उनके जन्म के समय रहे वजन का प्रभाव

परिचय: ये पत्रक संशोधन के बारे में सारी जानकारी देता है। आपके बच्चे को इस संशोधन में भाग लेने की अनुमति देने से पहले, आपको इस संशोधन के बारे में जानना जरूरी है। इस पत्रक में संशोधन के उद्देश्य, उनके फायदे और नुकसान के बारे में समझाया है। आप कोई तकनीकी शब्द का उपयोग इस पत्रक में हो और वह आपको समझ में नहीं आये, तो आप इसके बारे में समझीयत अधिकारी से पूछ सकते हैं। संशोधन का नाम और दृष्टिनी क्रमांक नीचे दिए गए है।

संशोधन के बारे में कोई भी सवाल हो तो कृपया नीचे दिए गए योजना से संपर्क करे

मित्रिविदा सनूर (मुख्य शोधकर्ता) - ९९२०१५०३५२

अपने अधिकारों तथा सुरक्षा के लिए कृपया नीचे दिए गए व्यक्ति से संपर्क करे
श्री जे. ए. शमाय (अध्यक्ष, आय. ई. सी)

परीक्षण का स्थल: मुंबई में स्थित अंगनवाड़ी केंद्र

संशोधन का हेतु: जीवन के पहले दो वर्ष बच्चे के सम्पूर्ण विकास के लिए अत्यंत महत्वपूर्ण होते हैं। इस दौरान, बच्चे का पोषण और विकास बहुत सारी विषयों पर निर्भर करता है। इन में, जन्म के समय बच्चे का वजन बहुत महत्वपूर्ण है। हालांकि इसे जागरूक करने के अनुसार, जीवन बच्चों का जन्म के समय बच्चे का वजन कम होता है, उनमें मास-पेशी के बजाय चर्ची की मात्र ज्यादा पायी जाती है। इससे उनके मास- पेशी के बजाय चर्ची की मात्र ज्यादा पायी जाती है। इससे उनके मास- पेशी के बजाय चर्ची की मात्र ज्यादा पायी जाती है। इसके साथ ही, उनकी बौद्धिक विकास पर भी असर हो सकता है। हमारे देश में इस प्रकार के संशोधन कम हुए हैं बच्चों का जन्म के समय बच्चे का वजन कम पाया गया है। इन विषयों को ध्यान में रखते हुए, यह संशोधन किया जाना वाता है।

कितने बच्चे भाग लेंगे? 
जिन बच्चों ने पोषण स्तर के संशोधन में भाग लिया होगा, उन में से 3 से 8 वर्ष के १२० - १५० बच्चों का चुना जायेगा।

इस परीक्षण के लिए मेरे बच्चे को क्या करना होगा?
अपके बच्चे को निम्मनलिखित कार्य करने भरे।
१) आप के बच्चे को एक बोर्ड और १० लकड़ी के विविध आकारों के ब्लॉक दिए जायेंगे। उन्हें उन आकारों को उनके सही जगहों पर काम से काम समय में रखना होगा।

२) आप के बच्चे को एक पेंसिल और कागज पर बने मजे दिए जायेंगे। उनको मजे के दो रेखाओं के बीच से, बिना उन्हें बुरे एक रेखा खींचनी होगी।

३) आप के बच्चे को कुछ विविध आकारों और रंगों के ब्लॉक दिए जायेंगे। उन्हें इन में से एक तरह दिखने वाले ब्लॉक को छोटे अलग-अलग रखना होगा।

४) आप के बच्चे को कुछ चित्र दिखाए जाएँगे। उन्हें इन चित्रों को पहचानना होगा और याद करके उनके नाम बताना होगा।

क्या मेरे बच्चे से ली गयी जानकारी गुप्त राखी जाएगी? इस जानकारी की किसके पास रहेगी?

आप के बच्चे से ली गयी जानकारी गुप्त राखी जाएगी। जानकारी का उपयोग केवल संशोधन के कार्य के लिए होगा।

अगर आप चाहें तो, हम आप के बच्चे से ली गयी जानकारी आपको उपलब्ध की जाएगी।

मेरे बच्चे से प्राप्त जानकारी का उपयोग कैसे होगा?

आपके बच्चे से प्राप्त जानकारी का उपयोग केवल संशोधन हेतू को पूरा करने के लिए किया जायेगा।
संस्कृत प्रकाश
बच्चे का नाम ___________________________ जन्म तारीख _____________________

माता / पिता का नाम और स्थायी ________________________________

में स्थायी करके वताती हूँ की नीचे दी गई सुचना

1) में सब सुनना पड़ी है और में यह सब समझ गई है। उसके बारे में सब सपूत बताया गया है। मुझे प्रथम पूछने की संभावित ही सी है और प्रथम के उत्तर दिये गये हैं।

2) में समझ गई हूँ की इस संबंधमें मेरे बच्चे को शामिल करना या न करना सिर्फ में तय करूँगी। अगर मुझे मेरे बच्चे का नाम प्रकाशित होगा तो में जब चाहे ऐसा कर सकूँगी।

3) में समझती हूँ के स्वातंत्र्य सत्ता संगठन या कोई अन्य संबंधित अधिकारी व्यक्तिकों मेरे बच्चे की आरोपण की जानकारी देने के लिए मेरी संभावित की जस्ता नहीं होगी। अगर मैंने मेरे बच्चे का नाम प्रकाशित होगा तो भी यह जानकारी देने के लिए मेरी संभावित की जस्ता नहीं। सिर्फ मेरे बच्छे का नाम किसीको न कहा जाए और कभी छापा न जाए।

4) इस संबंधमें वह जो मैंने हुई आरोपण की जानकारी का उपयोग करने पर कोई आपत्ति नहीं आने हैंगी, अगर इसका उपयोग केवल संबंधमें के काम के लिए होगा।

5) इस संबंधमें मेरे बच्छे को शामिल करने के लिए मुझे लोगों का काफी बकरा दिया गया था। मेरे बच्छे को इस संबंधमें शामिल करने के लिए में तय हैं। मुझे एक स्थायी और तारीख लिखी हैं। काम दी जाएगी।

स्थायी करता ______________________

मिस्स व्यक्तिगत संस्कृती ही उसका विवरण

की नीचे स्थायी की हैं व्यक्ति कहती हूँ की संबंधमें बारे में सब जानकारी जो इस संबंधमें बच्चे को शामिल करेगा उसे हैंगी।

संस्कृति देने वाले व्यक्ति का नाम __________________________

संस्कृति देने वाले व्यक्ति के हस्ताक्षर __________________________ तारीख __________

साक्षीदार का नाम __________________________

साक्षीदार के हस्ताक्षर __________________________ तारीख __________

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पोषण स्थर व बोधनात्मक विकासावर होणाऱ्या संशोधनाबद्दल माहिती पत्रक

शीर्षक: २ ते ४ वयोगटात्या मुलांचे पोषण स्थर व बोधनात्मक क्षमतेचे व व्याच्या जन्मत: असलेल्या वजनाचे तुलनात्मक परीक्षण

प्रस्तावना: हे पत्रक या संशोधनाबद्दल सर्व माहिती देते. तुमच्या मुलांना ह्या संशोधनात सहभागी करून घेण्यासाठी ते ह्यांनी संशोधनाचा उद्देश, त्याचे फायदे, तुम्ही या बदल तुम्हाला या पत्रकात माहिती दिलेली आहे. ह्या पत्रकातील काही शब्द हे वैज्ञानिक भाषेत असतील असल्यास ते ह्या प्रमाण काळात जन्माच्या परीक्षणाच्या निरसन करू शकतात. त्यांची नावे व दूरस्थ व्यक्ती क्रमांक खाली दिलेली आहे.

संशोधनाबद्दल काही प्रश्न असल्यास खालील व्यक्तिकी संपर्क साधावा

मिन्टविदा साउनुर (प्रमुख संशोधक) - १९२०१५०३५२

आपले अधिकार व सुरक्षितते संदर्भात प्रश्न असल्यास खालील व्यक्तिकी संपर्क करावा

श्री. जे. सी. शर्मा (अध्यक्ष, आय.ई.सी)

परीक्षण स्थळ- मुंबईतील आंगणवाडी केंद्रे

संशोधनाचा हेतु - प्रत्येक मुलासाठी आयुप्राचीन पहिली दोन वर्ष हि अतिशय महत्वाची असतात. मुलांच्या पोषण स्थळावर अनेक गोष्टींचा प्रभाव पडतो. असे पाहायला आले आहे की, जन्माच्या वेळेस ज्या मुलांचे वजन कमी असते, व्याच्या अंगान मुलांच्या प्रभाव तुसिरे व्यायाम जास्त असु शकते. त्यामुळे, अशा मुलात मधुमेह अध्याय ह्या संबंधीत आजार लाहान व्यायाम होऊ शकतात.

जन्माच्या वेळेस असलेल्या वजनाचा बोधनात्मक विकासावर सुदुर भरायला होऊ शकतो. त्याचे भरोसे जन्माच्या नंतर त्याची खालील असलेल्या पोषण स्थळाचा संशोधनात्मक विकासावर प्रभाव पडू शकतो. ह्या बाबतीत आपल्या देशात संशोधनाचे प्रमाण असतील ते आढळते.

ह्या संशोधणांत किती मुले भाग घेतील?
आप्सोही निवडलेल्या १२०० मुलांपेक्षा, ३ ते ४ वर्षीय १२० - १५० मुले परीक्षणाची निवडली जातील.

ह्या परीक्षणासाठी माझ्या मुलाला काय करावे लागेल?
तुमच्या मुलाला खालील गोष्टी सामग्रित्या जातिल-
1. एक फली व 10 ढोक्ये दिले जातील. तुमच्या मुलाला ते ढोक्ये आकार प्रमाणे लवकर लवकर लावायला सांगितले जाकल.

2. एक पंसिल व एक चक्रव्यूह दिले जातील. पंसिलनी चक्रव्यूहात दोन लाईन बधुन एक रेशा काढायला सांगितले जाइल पण कुठल्याहि लागला स्पर्श नाही झाला पाहिजे.

3. काही निरर्णिल्या आकाराचे व विविध संगाचे ढोक्ये दिले जातील. त्यातील सारखे दीसणारे ढोक्ये मुलाला एकत्र करावे लागतील.

4. चित्रे दाखवली जातील. ती चित्रे आढळून ओळखायला सांगितले जाइल.

आपण मुलाच्या सहभाग गुम ठेवल्या जाइल का? ती सर्व माहिती कोण काळे असेल?

या संशोधनात तुमच्या मुलाच्या सहभाग व सर्व माहिती पुढे ठेवण्यात येईल. सर्व माहिती फक्त संशोधक व संबंधित लोकांना दाखवली जाइल.

आपण मुलाची जी माहिती घेतली आहे, त्याचे काय केले जाइल?

या माहितीचा वापर संशोधनासाठी केला जाइल. तुमची इच्छा असताना तुम्हाला मुलाच्यांच्या सर्व माहिती दिली जाइल.

स्वतंत्र निरीक्षण गंभीरता मंडळ म्हणजेच काय?

आय. इ. झ. ही एक स्वतंत्र निरीक्षण गंभीरता मंडळ आहे. त्याच्या उद्देश्य आहे की संशोधनात भाग घेणाऱ्या व्यक्तीचे कायदेशीर सर्व हक्क सांबळल्या जातील. ही संस्था संशोधनात भाग घेणाऱ्यासारखे नवीन नावांमध्ये, त्यादरम्यान संशोधन कार्यांशी काही संबंध नाही. हा संस्थेचा समस्त कार्यक्रमांत व्यक्ती आहे - डॉक्टर, सामाजिक कार्यकर्ते, कायदांचे तज्ञ आणि उद्योगातील समाजातील मुख्य स्थानांतर. ही संस्था परवरणस्थी देख्याआढळी सर्व खात्री करून घेते.
विवाहपूर्वक संमती प्रमाण

मुलाचे नाव __________________________ जन तारीख ____________________

पालक/पाल्याचे नाव व सही __________________________

साक्षीदाराचे नाव __________________________

साक्षीदाराचे सही __________________________

तारीख ____________________

साक्षीदाराचे नाव __________________________

1) मी सर्व संबंधीत वाळणी आहे व मला मी सर्व संबंधीत संबंधी आहे. त्या कादम्बरी र संविधान देखील आली आहे. मला या विवाहपूर्वक संबंधी तंत्र देऊन, माझ्या प्रभावी जमीन विली आहून.

2) मला संबंधाने आहे की म्हा संबंधत माझ्या मुलाचा सहभागी करणे असल्य न करणे हे माझ्या माझे निर्णय असेल. मला जर नूतन व्यवस्था वापर काढाव्यात आल्या तर मी मला कर्मचार करू शकले.

3) माझ्या संबंधीत प्रमाणात होईल की मला संबंधत माझ्या मुलाचा सहभागी करणे असल्य न करणे हे माझ्यासोबत आरोप अंजन संबंधीत माझ्या वेध्यावाढ्यात माझ्या परताना लागणार नाही. तरी मी म्हा संबंधत नूतन माझ्या मुलाचे नाव काढाव्यांना तरी, मी म्हा परताना देते. परंतु कुटुंबाची परिस्थित माझ्या मुलाचे नाव कोणसोबत जाणार नाही किंवा झालेला जाणार नाही.

4) मी म्हा संबंधत उपभोक्ता-या कुटुंबाची माझीत्रो नाव आड जेणार नाही, जर ते पाहत शाळांकडून कामाक्षी असेल.

5) मला म्हा संबंधत मुलाचा सहभागी करण्यासाठी साठी संबंध विवाह प्रणालीत कामाचा पुरवा केला विला होता. मी माझ्या मुलाचा म्हा संबंधत माझ्या सहभागी करण्यास तपास आहे. मला एक-सही अशी जागी प्रंत, माझ्या मुलाचे साठी विली जाही.

सत्य कारणी __________________________

या व्यक्तिने संमती साधली ज्या विधान
मी वाळणी मी केलेली व्यक्ति दरवर्तीत की संबंधताना मी सर्व संबंधी सहभागी होण्याचा या व्यक्तिस साक्षीतल्या आहे.

संमती साधण-या व्यक्तियांचे नाव __________________________

संमती साधण-या व्यक्तियाची सही __________________________

साक्षीदाराचे नाव __________________________

साक्षीदाराची सही __________________________ तारीख ____________________

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Appendix IV
Interview Schedule: Nutritional Assessment

Schedule Code: Date:

Details of the Anganwadi

Personal Information:

Name of the child

Sex: M/ F  Date of birth:

Religion:  Contact no

Address

Details of the Family

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Name of the family member</th>
<th>Relation</th>
<th>Education</th>
<th>Occupation</th>
<th>Income</th>
</tr>
</thead>
<tbody>
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</table>

Total number of family members -

Birth Details (from the records): Was your baby born preterm? Yes/No

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (kg)</td>
<td></td>
</tr>
</tbody>
</table>

Current anthropometric measurements:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Measurements</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Upper Arm Circumference (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skinfold thickness: Biceps (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skinfold thickness: Triceps (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skinfold thickness: Subscapular (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skinfold thickness: Supraileac (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist-to-height ratio</td>
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<td></td>
</tr>
</tbody>
</table>

**Dietary Information: (from the mother/guardian)**

| Was the child exclusively breast-fed during infancy? | 1. Yes | 2. No |
| If yes, for how long was he/she exclusively breast-fed? |       |
| What was the total duration for which he/she was breast-fed? |       |
| At what age was complementary feeds started? |       |

**Medical History:**

Has your child ever been hospitalized from birth till date? Yes/No
If yes, how many times was he/she hospitalized?
What was the reason for hospitalization?
What was the duration of hospitalization?
What was the age at hospitalization?
Has he/she suffered from the following from birth till date –
TB – Yes/No
Malnutrition – Yes/No
Any other chronic illness – Yes/No

**Morbidity:** Has your child suffered from any illness in the past 15 days? Yes/No
If yes, give details

<table>
<thead>
<tr>
<th>Illness</th>
<th>Yes/No</th>
<th>No of episodes</th>
<th>Duration of each episode (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cold</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dengue</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Malaria</td>
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<td></td>
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<tr>
<td>Typhoid</td>
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<td></td>
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<tr>
<td>Jaundice</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Any other specify</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix V
Cognitive Assessment Record Sheet

Category: NBWNS/NBWS/LBWNS/LBWS  Schedule Code:  Date:

<table>
<thead>
<tr>
<th>Details of the Anganwadi</th>
</tr>
</thead>
</table>

Personal Information:

Name of the child

Sex: M/ F  Date of birth:

<table>
<thead>
<tr>
<th>Porteus Maze Test</th>
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<tbody>
<tr>
<td>Test (yr)</td>
</tr>
<tr>
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<table>
<thead>
<tr>
<th>Hoffman-Kasanein Concept Formation Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial No</td>
</tr>
<tr>
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<table>
<thead>
<tr>
<th>Recognition</th>
</tr>
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<tbody>
<tr>
<td>Sr no</td>
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<tr>
<td>-------</td>
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<tr>
<td>1</td>
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<td>2</td>
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<td>7</td>
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<td>8</td>
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<tr>
<td>9</td>
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</tbody>
</table>
Recall:

<table>
<thead>
<tr>
<th>List of Objects Recalled</th>
<th>Outcome (True/False response)</th>
<th>List of Objects Recalled</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

Seguin Form Board:

<table>
<thead>
<tr>
<th>Trial no</th>
<th>Time taken</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
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</table>

Details of Schooling:
Does your child attend *anganwadi*? Yes/No
Does your child attend nursery? Yes/No
If they attend either, since how many months/days has he/she started going?
Appendix VI

Pictures of Nutritional and Cognitive Assessment

Height Measurement

Measurement of Biceps Skinfold Thickness using Harpenden Caliper
Seguin Form Board Test: Child placing the blocks in the respective recesses

Poteus Maze Test: Child drawing a line on the Maze meant for Year VI
Hanfmann and Kasanin Concept Formation Test: Child sorting the blocks using the concept of ‘shapes’

Hanfmann and Kasanin Concept Formation Test: Child sorting the blocks using the concept of ‘colours’

Child performing the Recognition Test
Appendix VII
Picture Cards for Recognition Test
Appendix VIII
Picture Cards for Recall Test
Appendix IX
Publications and Presentations

Sociodemographic Factors Influencing Stunting in Young Children in Low Socioeconomic Areas of Mumbai City

Mitravinda S. Savanur
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Padmini S. Ghugre
Associate Professor, University Department of Food Science and Nutrition, S.N.D.T Women’s University, Mumbai, Maharashtra, India.

ABSTRACT
Stunting is an indicator of health and nutritional status. Reduction in stunting is imperative for economic growth. Understanding the factors influencing stunting is crucial in formulating intervention strategies. We therefore, studied the factors influencing stunting in young children aged 2 to 4 (n = 1205) years in low socioeconomic areas of Mumbai city. Height was measured and height-for-age Z scores were computed. Information regarding the parent’s education, income, child’s birth weight, birth order and exclusive breastfeeding were collected. Bivariate logistic regression was carried to determine the factors influencing stunting. In all, 24.4% were moderately and 10.8% were severely stunted. Father’s illiteracy, low per capita income and low birth weight significantly increased the odds of stunting while male gender and lower birth order reduced it. Improvement in father’s education might balance the intra-household power equations and have a cascading effect on the other factors that elevate the risk of stunting.

Introduction: Stunting is a reflection of long-term under-nutrition. Stunting in early life is associated with poor cognition and lower academic performance (Kar et al., 2008; Sokolovic et al., 2014). It may also lead early adiposity and increase the risk of non-communicable diseases (Martins et al., 2004; Clements et al., 2011).

According to the Joint Report by UNICEF, World Bank and WHO (2013), in 2012, 162 million children under five years of age were found to be stunted globally. It was estimated that 56% of the stunted children reside in South Asia while 36% in Africa. According to UNICEF (2013), the prevalence of stunting in India has been reported to be 48%. Within the country, the prevalence varies in the urban, rural and tribal areas.

Among the eight Indian cities studied, Mumbai has the highest number (45.4%) of stunted children (Agarwal, 2011). Mumbai is a culturally and economically diverse city. About 54% of the population the city resides in slums. Poverty is an important factor that influences the nutritional status of children. Besides, many sociodemographic factors also influence the nutritional status. Understanding these factors can help devise simple interventions to reduce the prevalence of stunting. We therefore, studied the factors influencing stunting in young children belonging to low socioeconomic areas in Mumbai.

Materials and Methods
The study was approved by Independent Ethics Committee (IEC no 09122), Navi Mumbai, Maharashtra, India.

Study Design: This cross-sectional study was carried out from July, 2013 to August, 2014 in the low socioeconomic localities of five areas of Mumbai city, Maharashtra, India. Children were recruited from anganwadis, the child-care and mother-care centres under Integrated Child Development Scheme (ICDS). We obtained a list of anganwadis from the five areas and 25 anganwadis were selected from each area by simple random sampling.

Participants: Twelve hundred and five children aged between 24 to 48 months on the day of the survey and those who had authentic birth weight records were recruited from the selected anganwadis. Any child suffering from chronic illness or born with congenital anomalies or extremely premature (< 28 weeks of gestational age) was excluded from the study. The parents and/or the guardian of the child were informed about the study in the local language and a written informed consent was obtained from them.

Variables:
Birth Weight and Age - Birth weight and date of birth were noted from either the hospital discharge card or the records of the anganwadi.

Measurements – Height was measured using a non-extensible, flexible and accurate measuring tape. The tape was calibrated against the stadiometer. The measurement was taken as per standard procedure (Fidanza & Keller, 1991).

Sociodemographic Variables: Information regarding the total number of family members, parent’s education, income, index child’s birth order and exclusive breastfeeding (EBF) were collected from the parent/caregiver via personal interview using a structured interview schedule. The per capita income was calculated by dividing the total family income by the total number of family members.

Statistical Analysis: WHO Anthro software version 3.2.2 was used to compute the Z scores for birth weight and height-for-age (HAZ). A value of < -2.0 SD for HAZ scores was classified as stunted. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 20.0. Frequency distribution was carried out for all the potential factors influencing stunting. Bivariate logistic regression was carried out and odds ratio (OR) with 95% confidence interval (CI) were computed to study the factors that modify the risk of stunting in children.

Results: Of the 1205 children, 51.8% were boys and 48.2% girls. There were 550 (45.6%) children aged 2 to 3 years and 655 (54.4%) aged 3 to 4 years.
Sociodemographic Characteristics – The sociodemographic details of the sample are given in Table 1. Around 13% mothers and 7% fathers were illiterate. Over 35% of the parents had dropped out of school. The mean per capita income per month was Rs. 2518.7 ± 1613.1. The per capita income of almost 40% of the families ranged between Rs. 1000 to 2000 whereas that for 10.7% was less than Rs 1000 per month.

The mean birth weight of the children was 2.7 ± 0.5 kg. In all, 20.5% had low birth weight (LBW) and 79.5% had normal birth weight (NBW). Ninety seven percent children (n=1173) were breastfed. The mean duration of EBF was 3.78 ± 2.2 months. Most of the participants were exclusively breastfed for three to six months.

Table 1: Sociodemographic Characteristics of the Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>N</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>624</td>
<td></td>
<td>51.8</td>
</tr>
<tr>
<td>Girls</td>
<td>581</td>
<td></td>
<td>48.2</td>
</tr>
<tr>
<td>Mother’s Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>161</td>
<td></td>
<td>13.3</td>
</tr>
<tr>
<td>Class I to IV</td>
<td>66</td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>Class V to IX</td>
<td>484</td>
<td></td>
<td>40.1</td>
</tr>
<tr>
<td>Matriculation</td>
<td>296</td>
<td></td>
<td>24.5</td>
</tr>
<tr>
<td>Higher Secondary Diploma</td>
<td>134</td>
<td></td>
<td>11.1</td>
</tr>
<tr>
<td>Graduation or above</td>
<td>64</td>
<td></td>
<td>5.2</td>
</tr>
<tr>
<td>Father’s Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>85</td>
<td></td>
<td>7.1</td>
</tr>
<tr>
<td>Class I to IV</td>
<td>43</td>
<td></td>
<td>3.4</td>
</tr>
<tr>
<td>Class V to IX</td>
<td>382</td>
<td></td>
<td>31.7</td>
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<tr>
<td>Matriculation</td>
<td>427</td>
<td></td>
<td>35.4</td>
</tr>
<tr>
<td>Higher Secondary Diploma</td>
<td>173</td>
<td></td>
<td>14.4</td>
</tr>
<tr>
<td>Graduation or above</td>
<td>89</td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>Per Capita Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; Rs 1000</td>
<td>129</td>
<td></td>
<td>10.7</td>
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<tr>
<td>Rs 1001-2000</td>
<td>479</td>
<td></td>
<td>39.8</td>
</tr>
<tr>
<td>Rs 2001-3000</td>
<td>355</td>
<td></td>
<td>28.1</td>
</tr>
<tr>
<td>Rs 3001-4000</td>
<td>155</td>
<td></td>
<td>12.9</td>
</tr>
<tr>
<td>Rs 4001-5000</td>
<td>17</td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td>&gt; Rs 5001</td>
<td>60</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Birth Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LBW (≤ 2.5 kg)</td>
<td>247</td>
<td></td>
<td>20.5</td>
</tr>
<tr>
<td>NBW (&gt; 2.5 kg)</td>
<td>723</td>
<td></td>
<td>60.1</td>
</tr>
<tr>
<td>Birth Order</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First-born</td>
<td>545</td>
<td></td>
<td>45.2</td>
</tr>
<tr>
<td>Second-born</td>
<td>413</td>
<td></td>
<td>34.3</td>
</tr>
<tr>
<td>Third-born</td>
<td>174</td>
<td></td>
<td>14.4</td>
</tr>
<tr>
<td>Later-born</td>
<td>73</td>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td>Duration of EBF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 3 months</td>
<td>462</td>
<td></td>
<td>41.8</td>
</tr>
<tr>
<td>3-6 months</td>
<td>66</td>
<td></td>
<td>5.6</td>
</tr>
</tbody>
</table>

Discusston: In our study, 24.4% children were moderately stunted and 10.8% were severely stunted. Poverty has been identified as a main determinant of undernutrition in developing countries (Kanjilal et al., 2010). Based on the National Family and Health Survey - 3 (NFHS - 3) data, Kanjilal et al (2010) and Martorell et al. (2012) observed that children from poorer households experienced higher burden of chronic undernutrition. Other studies from India also support this association (Mandal et al., 2014; Sonka, et al., 2014). The relationship of socioeconomic status (SES) and undernutrition appears to be mediated by a host of factors such as – availability and accessibility of health care, choice of foods, food preparation practices and intra-household food distribution (De Heanau et al., 2003).

In a patriarchal society like India, most of the decisions regarding the household expenditure, health care of the female members and children are taken by the head of the family or the father. Women have little or no decision-making powers. They have weaker control over household resources, tighter time constraints, less access to information and health services leading to lower self-esteem (Ahmed et al., 2012). These intra-household power equations are passed on from one generation to another and are deeply imbedded in the minds of people.

Further, gender disparities have been noted in intra-household distribution of food. The distribution of expensive foods (first class protein foods or fruits) is skewed towards the male gender (Ramchandran, 2006). In a study in Punjab, it was seen that the boys were served with milk and fruits along with the cereals while girls were given only cereals (Bose, 2003). Such disparity exists in provision of health care too. These differences are not economically driven but are strongly influenced by cultural factors (Ramchandran, 2006). This disparity against females is predominant among the economically and educationally backward sections.
Education is one of the ways to dilute this mindset and enable women to share an equal role in decision-making. However, gender disparity exists in the literacy levels of boys and girls. Since independence, the literacy levels of men and women have improved. However, the gender gap in the literacy levels (21%) continues to exist (Antony & Laenoia, 2008). Female illiteracy, poverty and lack of women empowerment are factors that determine the maternal nutritional status. Maternal undernutrition is predictor of LBW which further increases the risk of stunting (Ahmed et al., 2012).

Mothers who are well-educated are more aware about issues regarding nutrition, hygiene and health. Several reports from India and other nations suggest that mother’s illiteracy is strongly related to chronic undernutrition (Svedberg, 2007; Som et al., 2007; Misra et al., 2008; Mustaq et al., 2011; Basit et al., 2012; Bhayase et al., 2012). Further, improvement in mother’s education decreased the prevalence of stunting in Cambodia and China in the past two decades (Svedberg, 2007; Ickeda et al., 2013). However, in South Asia, malnutrition is seen to be rising irrespective of mother’s education mainly because of the gender-based rules that restrict the woman’s autonomy and her role in decision-making (Shroff et al., 2011).

In line with this, we found that father’s illiteracy and not mother’s increases the risk of stunting. Similar finding was reported in Maharashtra, India (Deshmukh et al., 2014). An educated father may probably make decisions keeping in mind the welfare of all the family members and also give adequate opportunity to women in decision-making process. This might reduce the gender disparity observed in intra-household food distribution and education opportunities. Adequate nutrition and health care can ensure optimal maternal nutritional status. Education will empower the woman, enable them to make informed decisions and also alleviate poverty. Education thus, appears to be a key factor that can help reduce gender disparity, poverty and the prevalence of LBW. All these can potentially decrease the burden of stunting.

We also found that the first-born children had lower odds of being stunted than the later born ones. More the children, lesser is the care and attention the child with higher birth order receives. This affects the time dedicated to feeding the child and seeking healthcare thus, increasing undernutrition.

Stunting is a multifactorial problem. The root causes of stunting are embedded in poverty, illiteracy and unemployment. Low birth weight and higher number of children are consequences of these root causes. Thus, efforts to reduce the prevalence of stunting should aim at these root causes. For long, mother’s education has been the centre of discussion of scientific literature. Father’s education is as important as that of mother’s if not more. Adult literacy programmes should be encouraged so that both men and women are better informed about issues regarding food, nutrition and health care, to consider, efforts to improve child nutritional status that primarily focus on the mother-child pair need to widen the programmes to include family and community particularly the male members.

Acknowledgement: We acknowledge the continuous support and co-operation of the CDPOs, anganwadi workers and helpers.

REFERENCE

Magnitude of undernutrition in children aged 2 to 4 years using CIAF and conventional indices in the slums of Mumbai city

Mitavinda S. Savanur* and Padmini S. Ghuage

Abstract

Conventional indicators – weight-for-age, height-for-age, weight-for-height and mid-upper arm circumference (MUAC) reflect different facets of the nutritional status. Weight-for-age is the most commonly used indicator. When used individually or in combination, conventional indices fail to depict the overall magnitude of undernutrition in the population. Composite Index of Anthropometric Failure (CIAF) is an alternative classification system which attempts to fill this lacuna. Thus, we undertook this study with the objective to compare the prevalence of undernutrition using CIAF and the conventional indices. We included 634 children aged between 2 to 4 years from anganwadi’s located in three areas of Mumbai. Weight, height and MUAC measurements were taken. Z scores were computed for weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ) using WHO Anthro software. Children were classified as per the conventional indices and CIAF. The prevalence of underweight, stunting and wasting was 35.7%, 33.8% and 18.5% respectively. None of the children had MUAC <11.5 cm. About 1% of the children were moderately wasted according to MUAC. As per CIAF, 47.8% children were undernourished. According to CIAF, one-third of the undernourished children had single anthropometric failure while half of them had dual failure and 17.1% had multiple failures. When compared with the conventional indices, CIAF could recognize 12.1%, 14.0%, 29.3% and 46.7% more undernourished children than WAZ, HAZ, WHZ and MUAC respectively. In conclusion, CIAF is seen to have many advantages over the conventional indices. CIAF is useful in assessing the overall magnitude of undernutrition and identifying children with multiple anthropometric failures. It also recognizes more undernourished children than all the conventional indices. Therefore, CIAF should be used more widely as a tool for nutritional assessment particularly in developing countries where the burden of undernutrition is high.

Keywords: CIAF, Underweight, Stunting, Wasting, Nutritional status, Children, India

Background

Undernutrition among children under five years is traditionally assessed using anthropometric indices such as – weight-for-age, height-for-age, weight-for-height and mid-upper arm circumference (MUAC). Stunting or low height-for-age is an indicator of chronic undernutrition which is manifested as poor skeletal growth. Low weight-for-height reflects wasting or acute undernutrition with loss of lean as well as fat mass [1]. On the other hand, low MUAC (<11.5 cm) is not only suggestive of severe wasting or severe acute malnutrition but also indicative of morbidity and risk of mortality [2, 3]. Underweight or low weight-for-age, on the other hand, is indicative of both acute and chronic undernutrition [1]. These indices reflect different facets of undernutrition. Although underweight, stunting and wasting reflect different facets of undernutrition, they are not mutually exclusive categories. For instance, a child who is found to be stunted can also be underweight and wasted at the same time. Hence, a sum of the children who are underweight, stunted and wasted in a group does not reveal the overall number of undernourished children in a population. The conventional indices therefore fail to provide the overall prevalence of undernutrition in a group.

There is another concern with the use of conventional indices. Weight-for-age is most commonly used to assess

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the nutritional status. This may be because underweight indicates both acute and chronic undernutrition. However, underweight is not the summation of children who are wasted and stunted. As a result, we might tend to miss out on children who are stunted and wasted if underweight is used as a sole indicator of nutritional status.

In the year 2000, Swedish Economist Prof. Peter Svedberg suggested an alternative measure to assess the overall magnitude of undernutrition – Composite Index of Anthropometric Failure (CIAF). CIAF identifies seven groups of children including those without any form of anthropometric failure (Table 1). A summation of the groups B, C, D, E, F and Y gives the total magnitude of undernutrition. At the same time, it can be useful in detecting multiple anthropometric failures [8].

Investigators in Kenya, China and Bangladesh have used CIAF to assess the extent of undernutrition [5–7]. In Kenya, Berger et al estimated the prevalence of undernutrition among children with HIV/AIDS [5]. Khan et al and Pei et al also identified the sociodemographic factors determining overall undernutrition [7, 6]. Nandy and Miranda have used the national data from seven developing countries to calculate the CIAF and compare it with prevalence of underweight in the same areas [8].

In India, Nandy et al was the first to use the concept of CIAF on the data of 1998 – 99 National Family Health Survey – 2 (NFHS – 2) [1]. Thereafter most of the Indian studies that have used CIAF have been conducted in rural or tribal areas of West Bengal [9–15]. Only two studies so far have used CIAF in an urban setting i.e. in Coimbatore, Tamil Nadu and Bankura town, West Bengal [16, 17].

In Maharashtra state, the prevalence of underweight, stunting and wasting in under-five children in rural and urban areas was 37 %, 46 % and 17 % respectively. The nutritional status of under-five children in Mumbai was reportedly worse than the other urban areas in the state. The prevalence of underweight and stunting was 40 % and 14 % higher respectively in the slum than the non-slam areas of Mumbai [18]. The overall extent of undernutrition in the children belonging to the slums in Mumbai remains unknown.

We therefore conducted the present study with an objective to compare the prevalence of undernutrition by using CIAF and the conventional indices.

**Methods**

The study was approved by Independent Ethics Committee (IEC no 09122), Navi Mumbai, Maharashtra, India.

**Study design**

This cross-sectional study was carried out from July, 2013 to January, 2014 in the slums of Mumbai city, Maharashtra, India. We undertook the study in three urban slum areas located in the western suburbs of the city. Each of these areas had 140 to 150 anganwadis each. Anganwadi is a child-care and mother-care centre which is run by the Integrated Child Development Service (ICDS) in India. We obtained a list of anganwadis in each of these areas from the respective Child Development Project Officers (CDPO). From this list, every sixth anganwadi was selected by simple random sampling. Thus, from every area, we selected 25 anganwadis each (Fig. 1). Participants: Six hundred and thirty four children aged between 2 to 4 years participated in the study. The inclusion and exclusion criteria for including the children in this study were.

**Inclusion criteria**

Children who (i) were beneficiaries of the anganwadi, (ii) had authentic records of their date of birth and (iii) had completed 24 months of age and were less than or equal to 48 months were included in the study. Age was calculated on the basis of their date of birth to the nearest one month.

**Exclusion criteria**

Children who were – (i) suffering from any chronic illness that influenced their nutritional status, (ii) born with congenital anomalies, (iii) born extremely premature (<28 weeks of gestational age).

Parents and/or guardians of the children were explained about the study procedure in the local language and an informed consent was obtained from them.

**Assessment of nutritional status**

Weight and height measurements of all the children were taken using standard procedure [19]. Children were weighed on a digital weighing scale (Dr Gene Health and Wellness: Model no: MS8270) with an accuracy of 0.1 kg. Height was measured using a non-

<table>
<thead>
<tr>
<th>Group</th>
<th>Description of the group</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No anthropometric failure</td>
<td>Normal WAZ, HAZ and WHZ</td>
</tr>
<tr>
<td>B</td>
<td>Wasting only</td>
<td>WAZ &lt; -2SD but normal WAZ and HAZ</td>
</tr>
<tr>
<td>C</td>
<td>Wasting and underweight</td>
<td>WAZ and WAZ &lt; -2SD but normal HAZ</td>
</tr>
<tr>
<td>D</td>
<td>Wasting, underweight and stunting</td>
<td>WAZ, WAZ and HAZ &lt; -2SD</td>
</tr>
<tr>
<td>E</td>
<td>Stunting and underweight</td>
<td>HAZ and WAZ &lt; -2SD but normal WHZ</td>
</tr>
<tr>
<td>F</td>
<td>Stunting only</td>
<td>HAZ &lt; -2SD but normal WAZ and WHZ</td>
</tr>
<tr>
<td>Y</td>
<td>Underweight only</td>
<td>WAZ &lt; -2SD but normal HAZ and WHZ</td>
</tr>
</tbody>
</table>
extensible, flexible measuring tape with an accuracy of 0.1 cm which was calibrated against the standard anthropometric scale. Based on these measurements, weight-for-age Z scores (WAZ), height-for-age Z scores (HAZ) and weight-for-height Z scores (WHZ) were computed. MUAC was measured using a non-extensible, flexible measuring tape at the mid-point between the acromion and olecranon processes of the child's arm flexed at 90° angle. The child was then made to relax the arm so that it hangs just away from the side of the body and the circumference was measured at the mid-point with an accuracy of 0.1 cm [20].

Children with WAZ, HAZ and WHZ scores between −3.0 to −2.0 SD were classified as moderately underweight, stunted and wasted respectively. Those with WAZ, HAZ and WHZ scores were < −3.0 SD were classified as severely underweight, stunted and wasted respectively. And, those children who had Z scores > −2.0 SD were classified as 'normal' [21]. MUAC < 11.5 cm and between 11.5 to 12.5 cm were classified as severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) respectively. Those with MUAC > 12.5 cm were considered 'normal' [3]. Further, children were also classified using CIAF [1].

Statistical analysis
WAZ, HAZ and WHZ scores were computed using WHO Anthro software version 3.2.2. The data was analyzed using SPSS version 20. For WAZ, HAZ, WHZ and MUAC one-way ANOVA was used to analyze the difference in the mean Z scores between boys and girls. Chi-square tests were performed to study the age-wise and gender-wise differences in the prevalence of undernutrition.

Results
There were 53.6 % (n = 340) boys and 46.4 % (n = 294) girls in the study. The mean age of the children was 3.1 ± 0.8 years. The mean anthropometric measurements of children are presented in Table 2. Boys weighed significantly more (F = 12.039, p = 0.001) and had a significantly higher MUAC (F = 4.151, p = 0.042) than the girls.
Table 2 Mean anthropometric measurements of boys and girls (n = 634)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Boys (n = 343)</th>
<th>Girls (n = 291)</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>11.9 ± 1.8</td>
<td>11.4 ± 1.8</td>
<td>12.639</td>
<td>0.001</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>90.1 ± 7.2</td>
<td>89.2 ± 7.0</td>
<td>2.427</td>
<td>0.120</td>
</tr>
<tr>
<td>WAZ</td>
<td>-1.6 ± 1.0</td>
<td>-1.7 ± 0.9</td>
<td>2.194</td>
<td>0.139</td>
</tr>
<tr>
<td>HAZ</td>
<td>-1.5 ± 1.2</td>
<td>-1.6 ± 1.1</td>
<td>0.921</td>
<td>0.337</td>
</tr>
<tr>
<td>WHZ</td>
<td>-1.1 ± 1.0</td>
<td>-1.1 ± 0.9</td>
<td>0.000</td>
<td>0.987</td>
</tr>
<tr>
<td>MUAC (cm)</td>
<td>14.9 ± 1.1</td>
<td>14.8 ± 1.1</td>
<td>4.151</td>
<td>0.042</td>
</tr>
</tbody>
</table>

WAZ: Weight-for-age Z score, HAZ: Height-for-age Z score, WHZ: Weight-for-height Z score, MUAC: Midupper arm circumference

However no statistical differences were seen between boys and girls for the other anthropometric parameters.

Nutritional Status

Using conventional indices

Children were classified as per WHO Growth Standards [3, 21]. One hundred and seventy-six (27.8%) children were moderately underweight and 58 (7.9%) were severely underweight (Table 3). One hundred and forty-three (22.6%) children and 71 (11.2%) were moderately and severely stunted respectively. One hundred and four (16.4%) children and 13 (2.1%) children had moderate and severe wasting respectively. None of the children had a MUAC < 11.5 cm. Seven children (1.1%) had MAM according to MUAC. There were no significant differences were observed in the prevalence rates in boys and girls. Similarly, no statistical differences were seen in the prevalence of underweight and stunting across the age groups. However, significantly higher number of children in the age group of 3 to 4 years were moderately wasted than children aged 2 to 3 years of age (20.3% vs 12.8%; χ2 = 7.983, p = 0.018).

Using composite index of anthropometric failure

According to CIFA classification, 331 children (52.2%) were well nourished (Table 4). Nearly half the children i.e. 303 (47.8%) were undernourished. Of all the undernourished children, 101 children (33.3%) suffered from single anthropometric failure (Group – B, F, and Y). Almost half the undernourished children (49.5%) suffered from dual anthropometric failure (Group – C and E) while fifty-two children i.e. 17.1% experienced multiple failures i.e. they were underweight, stunted and wasted at the same time. No age-wise (χ2 = 11.516, p = 0.007) and sex-wise (χ2 = 10.864, p = 0.003) differences were noted in the prevalence of single, dual and multiple anthropometric failures.

CIFA vs Conventional indices of undernutrition

CIFA could identify more undernourished children than the conventional indices. The prevalence of undernutrition

Table 3 Prevalence of undernutrition according to the conventional indices

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Classification</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Boys (%) (n)</th>
<th>Girls (%) (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 to 3 % (n)</td>
<td></td>
<td>3 to 4 % (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAZ (Underweight)</td>
<td>Normal</td>
<td>64.5 (209)</td>
<td>64.2 (199)</td>
<td>66.8 (227)</td>
<td>61.6 (181)</td>
<td>64.4 (408)</td>
</tr>
<tr>
<td>WAZ (Underweight)</td>
<td>Moderate underweight</td>
<td>29.6 (96)</td>
<td>25.8 (80)</td>
<td>25.6 (87)</td>
<td>30.3 (99)</td>
<td>27.8 (176)</td>
</tr>
<tr>
<td>WAZ (Underweight)</td>
<td>Severe underweight</td>
<td>5.9 (19)</td>
<td>10 (31)</td>
<td>7.6 (26)</td>
<td>8.2 (24)</td>
<td>7.9 (50)</td>
</tr>
<tr>
<td>WAZ (Underweight)</td>
<td>χ²</td>
<td>4.273</td>
<td></td>
<td>1.962</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAZ (Underweight)</td>
<td>p</td>
<td>0.118</td>
<td></td>
<td>0.375</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAZ (Stunting)</td>
<td>Normal</td>
<td>66.0 (214)</td>
<td>66.5 (208)</td>
<td>67.6 (230)</td>
<td>66.6 (190)</td>
<td>66.2 (420)</td>
</tr>
<tr>
<td>HAZ (Stunting)</td>
<td>Moderate stunting</td>
<td>22.2 (72)</td>
<td>22.9 (71)</td>
<td>20.9 (71)</td>
<td>24.5 (72)</td>
<td>22.6 (143)</td>
</tr>
<tr>
<td>HAZ (Stunting)</td>
<td>Severe stunting</td>
<td>11.7 (38)</td>
<td>10.6 (33)</td>
<td>11.5 (39)</td>
<td>10.9 (32)</td>
<td>11.2 (71)</td>
</tr>
<tr>
<td>HAZ (Stunting)</td>
<td>χ²</td>
<td>0.202</td>
<td></td>
<td>1.175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAZ (Stunting)</td>
<td>p</td>
<td>0.904</td>
<td></td>
<td>0.556</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHZ (Wasting)</td>
<td>Normal</td>
<td>85.8 (278)</td>
<td>77.1 (239)</td>
<td>79.7 (271)</td>
<td>83.7 (266)</td>
<td>81.5 (517)</td>
</tr>
<tr>
<td>WHZ (Wasting)</td>
<td>Moderate wasting</td>
<td>12.7 (41)</td>
<td>20.3 (63)</td>
<td>17.9 (61)</td>
<td>14.6 (43)</td>
<td>16.4 (104)</td>
</tr>
<tr>
<td>WHZ (Wasting)</td>
<td>Severe wasting</td>
<td>1.5 (6)</td>
<td>2.6 (8)</td>
<td>2.4 (8)</td>
<td>1.7 (5)</td>
<td>2.1 (13)</td>
</tr>
<tr>
<td>WHZ (Wasting)</td>
<td>χ²</td>
<td>7.983</td>
<td></td>
<td>1.688</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHZ (Wasting)</td>
<td>p</td>
<td>0.018</td>
<td></td>
<td>0.430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC (Acute malnutrition)</td>
<td>Normal (≥ 12.5 cm)</td>
<td>90.1 (321)</td>
<td>98.7 (306)</td>
<td>98.8 (336)</td>
<td>99.0 (291)</td>
<td>98.9 (627)</td>
</tr>
<tr>
<td>MUAC (Acute malnutrition)</td>
<td>MAM (11.5 to 12.5 cm)</td>
<td>0.9 (3)</td>
<td>1.3 (4)</td>
<td>1.2 (4)</td>
<td>1.0 (3)</td>
<td>1.1 (7)</td>
</tr>
<tr>
<td>MUAC (Acute malnutrition)</td>
<td>χ²</td>
<td>0.193</td>
<td></td>
<td>0.025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC (Acute malnutrition)</td>
<td>p</td>
<td>0.720</td>
<td></td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WAZ: Weight-for-age Z score, HAZ: Height-for-age Z score, WHZ: Weight-for-height Z score, MUAC: Midupper arm circumference
Table 4 Prevalence of undernutrition according to CIAF

<table>
<thead>
<tr>
<th>Group</th>
<th>Description of the group</th>
<th>Age (years)</th>
<th>Sex Boys % (n)</th>
<th>Girls % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No anthropometric failure</td>
<td>53.7 (174)</td>
<td>50.6 (157)</td>
<td>54.1 (184)</td>
<td>50.2 (147)</td>
</tr>
<tr>
<td>B</td>
<td>Wasting only</td>
<td>1.2 (4)</td>
<td>1.3 (4)</td>
<td>1.3 (4)</td>
<td>2.6 (17)</td>
</tr>
<tr>
<td>C</td>
<td>Wasting and underweight</td>
<td>6.0 (20)</td>
<td>6.7 (23)</td>
<td>8.5 (25)</td>
<td>7.5 (48)</td>
</tr>
<tr>
<td>D</td>
<td>Wasting, underweight and stunting</td>
<td>6.8 (22)</td>
<td>9.7 (33)</td>
<td>64 (19)</td>
<td>82 (52)</td>
</tr>
<tr>
<td>E</td>
<td>Stunting and underweight</td>
<td>17.6 (57)</td>
<td>13.8 (47)</td>
<td>18.7 (55)</td>
<td>16.1 (102)</td>
</tr>
<tr>
<td>F</td>
<td>Stunting only</td>
<td>9.6 (31)</td>
<td>8.8 (30)</td>
<td>10.2 (30)</td>
<td>9.4 (60)</td>
</tr>
<tr>
<td>Y</td>
<td>Underweight only</td>
<td>4.9 (16)</td>
<td>2.9 (10)</td>
<td>4.2 (14)</td>
<td>3.7 (24)</td>
</tr>
<tr>
<td></td>
<td>Total anthropometric failure</td>
<td>46.3 (150)</td>
<td>45.8 (156)</td>
<td>50.0 (147)</td>
<td>47.8 (303)</td>
</tr>
</tbody>
</table>

\[\chi^2\] 11.516, 10.864

p 0.074, 0.093

According to CIAF was 47.8%. On the other hand, using conventional indices, 35.7% were underweight, 33.8% were stunted and 18.5% were wasted. Thus, CIAF could recognize 12.1%, 14.0% and 29.3% more undernourished children than WAZ, HAZ and WHZ respectively. CIAF could recognize 46.7% more children as undernourished than MUAC. Among all the children classified as well nourished by MUAC, 16.1% had single anthropometric failure while 23.4% and 7.2% suffered from dual and multiple failures respectively (Table 5).

Discussion

The present study compared the prevalence of undernutrition by using CIAF and the conventional indices. The prevalence of undernutrition according to CIAF was 47.8%. On the other hand, according to the conventional indices 35.7%, 33.8% and 18.5% children were underweight, stunted and wasted respectively. Also, about 1% children were classified as MAM according to MUAC.

Some researchers have used CIAF to assess the prevalence of undernutrition. Nandy and Miranda [8] computed the CIAF using the national data from 1998 to 2001 of seven developing countries - India, Ethiopia, Nepal, Tanzania, Zimbabwe, Bolivia and Peru. The prevalence rates in Peru (23.3%), Bolivia (26.6%) and Zimbabwe (35.8%) were lower than that observed in our study while in Nepal (56.5%) and Ethiopia (58%) rates were much higher. Recent reports indicate that 21.4% children were undernourished in rural China [6] while in rural Bangladesh the prevalence was 58.7% [7]. On the other hand, the rates were slightly lower in urban Bangladesh (47.9%) and were comparable to that observed in our study [7].

In India, a total of 59.8% children were reported to be undernourished using the NFHS – 2 data collected during 1998 – 99 [8]. Other studies in India have been mainly conducted in rural and tribal West Bengal wherein the prevalence rates ranged from 50.2 to 73.0% which were much higher than those observed in our study [9-14]. Similarly, 59.6% were reported to be undernourished in rural Wardha, Maharashtra state [22]. Factors associated with undernutrition in these rural and tribal areas were reported to be birth order, low birth weight, breastfeeding practices and mother’s education [15]. Only two studies have been reported from urban areas of India, one from Tamil Nadu [16] and another from West Bengal [17]. The prevalence rates in these studies were higher than our study. These differences can be possibly attributed to various factors such as socioeconomic status, educational level, living conditions, maternal health, birth weight, feeding practices and rates of infections. However, we have not studied the factors influencing the overall prevalence of undernutrition as a part of this paper.

In the studies where CIAF and conventional indices were used together, CIAF identified more undernourished children than the latter [8, 14, 16, 23]. Nandy and Miranda [8] found that the use of weight-for-age underestimated the prevalence by 9.7 to 21.7% as compared to CIAF. Similar findings have been noted by some other researchers in India [14, 16, 23]. However, these workers...
compared CIAF with only WAZ. We compared CIAF with WAZ, HAZ, WHZ and MUAC. WAZ underestimated the prevalence by 12.1%, HAZ by 14.0% and WHZ by 29.3% as compared to CIAF. Also, MUAC identified 1.1% children as MAM but failed to identify 46.7% children who had varying degrees of undernutrition. Thus the conventional indices underestimated the prevalence of undernutrition and erroneously classified a sizeable section of the population as 'normal'.

Further, conventional indicators do not give a holistic picture of the nutritional status of a population. For instance, by using conventional indices we can find out how many children are underweight. But, there could be some children who are wasted as well as underweight. Such groups of children suffering from two or more anthropometric failures remain unidentified when conventional measures are used. In view of this, Svedberg added three categories to the existing conventional indicators (Group C: wasting and underweight, D: underweight, stunting and wasting and E: underweight and stunting) [4]. In this study, only 33% of the undernourished children exhibited single anthropometric failure while the remaining had either dual or multiple anthropometric failures which was not revealed with the use of conventional indices. These children exhibiting multiple anthropometric failures will require regular counseling and monitoring than those having single anthropometric failure.

In India, ICDS is the national programme that aims at reducing undernutrition and improving the nutritional status of children up to six years of age. Presently, the ICDS uses weight-for-age and MUAC as the indicators of nutritional status. WAZ identifies underweight children while MUAC recognizes those with extreme wasting. Stunted and moderately/severely wasted children are not identified as undernourished. As a result, a significant proportion of children suffering from dual or multiple failures are missed out. These vulnerable children fail to receive adequate attention and appropriate counseling from the anganwadi workers. This can further increase the burden of undernutrition and risk for morbidity. Thus, with the use of CIAF all the undernourished children can be identified.

The ICDS routinely weighs the children. If height is also measured then CIAF can be easily used. Using CIAF will not incur any extra financial burden on the government machineries. The use of CIAF will not only help in assessment but also in monitoring the growth of these children suffering from various degrees of anthropometric failure. Parents can be sensitized and appropriately counseled regarding their child’s nutritional status. Such steps can help reduce the overall burden of undernutrition and also pave the path towards attaining the Millennium Development Goals (MDGs).

The strength of the present study is that this is the first study to have used CIAF to estimate the overall prevalence of undernutrition in the slums of Mumbai. Also, the study compares the prevalence rates of CIAF with all the conventional indices including MUAC. The limitation of our study was that it was carried out in three slum areas of Mumbai city. It would have been worthwhile if similar data was gathered from the non-slam areas where people across the socioeconomic spectrum reside. Also, we used only anthropometric indices and did not include any biochemical parameters for the assessment of nutritional status.

**Conclusion**

CIAF is a useful tool which provides a holistic picture of the overall prevalence of undernutrition. Conventional indicators when used individually grossly underestimate the extent of undernutrition. ICDS should thus, consider using CIAF at the national level as a step towards reducing the overall burden of undernutrition in children.

**Competing interests**

The authors declare that they have no competing interests.

**Authors’ contributions**

MSS and PSG conceptualized and designed the study. MSS collected and analyzed the data. MSS drafted the manuscript. PSG provided critical inputs to the manuscript. All authors read and approved the final manuscript.

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**References**


Influence of Birth Weight and Stunting on Selected Cognitive Functions of Young Children in Low Socioeconomic Areas of Mumbai City

Mitrovinda S. Savanur, Mrinalini Purandare and Padmini S. Ghugre

ABSTRACT

The first 1000 days of life are critical for human brain growth. We therefore, examined if birth weight and stunting influence the cognitive functions of young children. Children aged 3 to 4 years (n = 122) residing in low socioeconomic areas of Mumbai were selected in four groups - normal birth weight non-stunted (NBWNS), normal birth weight stunted (NBWS), low birth weight stunted (LBWS) and low birth weight non-stunted (LBWNS). Birth weight was collected from records. Height was measured and height-for-age Z scores (HAZ) were computed. For measuring cognitive functions Seguin Form Board test, Porteus Maze test, Hanfmann Kasanin Concept Formation test, Recognition, and Recall were administered. The NBWS and LBWS performed poorly than NBWNS and LBWNS, though differences were non-significant. Poverty and lesser exposure to formal schooling may have also influenced the performance of the stunted children. The study thus suggests that stunting may influence the cognitive functions.

Key words: Cognitive functions, Stunting, Birth weight, Children.

INTRODUCTION

The first 1000 days of life are critical for human brain growth. Birth weight is one of the earliest indicators of the health status of the newborn. Infants/children born with intraterine growth restriction (IUGR), small-for-gestational age (SGA) have reduced volumes of the cerebellum, hippocampus, amygdala and the cerebral cortex (Tolsa et al., 2004; Geva et al., 2006; De Bie et al., 2011; Skrane, Lohaugen, Martinussen, Haberg, Brubakk, & Dale, 2013). Deficits in visuospatial, visuomotor integration, memory and executive functions have been reported in very low birth weight (VLBW) children/
adolescents (Luu, Vohr, Allan, Schneider, & Ment, 2011; Ritter, Nelle, Perrig, Steilin, & Everts, 2012), IUGR children (Geva et al., 2006) and SGA adults (Ostgard et al., 2014). In addition to birth weight, stunting (low height-for-age) in early life has also been associated with poor visuospatial function, memory and executive functions (Kar, Rao, & Chandra Mouli, 2008; Laus, Vales, Costa, & Almeida, 2011; Sokovolic, Selvan, Srinivasan, Thankachan, Kupad, & Thomas, 2014). Thus, fetal growth and nutritional status in childhood are likely to influence the cognitive functions.

Researchers so far have studied the influence of either birth weight or stunting on cognition. There are few studies that investigated influence of both, birth weight and stunting on cognitive functions. Therefore, we examined if there was any difference in the cognitive functions of the children across the four groups namely - normal birth weight non-stunted (NBWNS), normal birth weight stunted (NBWS), low birth weight stunted (LBWS) and low birth weight non-stunted (LBWNS). We hypothesized that the LBWS children would have poorer cognitive functions as compared to the other groups.

MATERIALS AND METHODS

The study was approved by Independent Ethics Committee (IEC no 09122), Navi Mumbai, Maharashtra, India. Parents and/or guardians of the children were explained about the study procedure in the local language and a written informed consent was obtained from them.

Study Design

We had initially conducted a cross-sectional study to assess the nutritional status of 655 children aged 3 to 4 years belonging to low socioeconomic sections in Mumbai city from July, 2013 to July, 2014. From this group, a sub-sample of 20% was drawn.

Participants

Children were recruited from anganwadis, the child-care and mother-care centres under Integrated Child Development Scheme (ICDS). From the main study, children were selected in four groups (NBWNS, NBWS, LBWS and LBWNS) based on the inclusion criteria given in Table 1. From the list participants who met the inclusion criteria, 45 participants were selected in each group by simple random sampling. In the LBWNS group, 43 participants met the inclusion criteria. Some children were unavailable for the test or were unwell. In all, 122 children completed all the cognitive tests.

Table 1

Criteria for Selection of Children for Cognitive Assessment

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Description</th>
<th>Birth weight (kg)</th>
<th>HAZ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal Birth Weight and Non-Stunted (NBWNS)</td>
<td>≥ 2.7</td>
<td>≥ -1.50</td>
</tr>
<tr>
<td>2</td>
<td>Normal Birth Weight and Stunted (NBWS)</td>
<td>≥ 2.7</td>
<td>≤ -2.00</td>
</tr>
<tr>
<td>3</td>
<td>Low Birth Weight and Stunted (LBWS)</td>
<td>&lt; 2.5</td>
<td>≥ -2.00</td>
</tr>
<tr>
<td>4</td>
<td>Low Birth Weight and Non-Stunted (LBWNS)</td>
<td>&lt; 2.5</td>
<td>≥ -1.50</td>
</tr>
</tbody>
</table>

Variables

Date of Birth and Birth Weight: Birth weight and date of birth of the children were obtained from either the anganwadi records or the hospital discharge card where the child was born. Age was calculated using the date of birth to the nearest one month.

Height: Height was measured using a non-extensible, flexible measuring tape with an accuracy of 0.1 cm which was calibrated against the standard stadiometer. The measurement was taken in triplicates as per the standard procedure (Fidanza & Keller, 1991). The mean value was used for further calculations. Stunting was defined as height-for-age Z score (HAZ) ≤ -2 SD. Non-stunted or control group included children with HAZ ≥ -1.5 SD.

Performance IQ - Performance IQ was assessed using Seguin Form Board Test (SFBT). The tasks in the test indicate the children’s motor dexterity, visuo motor skills, spatial organization and speed of performance (Desai & Kothare, 2009). The tests were conducted as per the standard procedure described in the manual (Goel & Bhargava, 1990).

Planning Performance - The Porteus maze test (PMT) examines the child’s ability to ‘use planning capacity, prudence and mental alertness in a new situation of a concrete nature’. The test consists of a series of mazes graded in difficulty and standardized for children aged three to 14 years of age. The tests were conducted and scored as per the standard procedure described in the manual (Porteus, 1924). Some children who were accustomed to writing on the slate using a pencil chalk could not hold the pencil properly. Such children were asked to perform the test on the slate instead of the paper. The scores of the PMT are given as mental ages.

Thinking Performance – Hanfmann, and Kasanin Concept Formation Test (HKCFT) was used to assess the thinking performance of the children. The test box contains 22 blocks differing in colour, shapes, size and height. The original test was modified to
suit the young children.

As per the modified procedure, the children were asked to sort the blocks and make groups of similar looking blocks. They were given an example of how to arrange items in similar groups by using items such as – pens, erasers and clips. Once the child completed sorting, the examiner asked him/her on what basis did he/she sort the blocks. The child was then asked to repeat the same using new concepts until he/she was unable to think of new ways to do so. The examiner made a note of the different concepts that the child used while sorting.

Memory Performance – Memory performance was assessed by two tests – recognition and recall. In recognition, a set of 40 cards containing pictures of items used in day-to-day life that the children would be familiar with were selected. They were shown the first 20 cards one after the other with sufficient time for them to identify the picture. The first 20 cards were randomly mixed with the remaining cards. The cards were shown to the child again. The child was asked to recognize if he/she was shown the picture card earlier in the first set. The child’s response was noted down as – correct or incorrect.

In recall, a set of 15 picture cards (different from Recognition) familiar to the child were shown. Before showing the cards, the child was instructed to carefully look at each card and remember it. The child was asked to recall the names of the pictures shown to him/her. All the names that the child was able to recollect were noted down.

PROCEDURE
All the tests were administered by two trained psychologists. Each psychologist administered the tests to one child at a time in the anganwadi premises or a neighboring house between 11:00 to 13:30 hours. The tests were administered in the following sequence – Hanfmann, and Kasanin Concept Formation test, Recall, Porteus Maze test, Seguin Form Board test and Recognition. Care was taken to keep sufficient time gap between Recall and Recognition to avoid any confusion among the children.

STATISTICAL ANALYSIS
HAZ was computed using WHO Anthro software version 3.2.2. The data was analyzed using Statistical Program for Social Sciences (SPSS) version 20. According to the Kolmogrov-Smirnov test, the distributions of all the test scores were skewed. Kruskal-Wallis test was used to compare the scores of SFBT, recognition, recall and PMT performance of the children in the four groups. Chi-square was used to study the differences between the scores of HKCFT.

RESULTS
Overall, 122 children completed all the tests with 52% girls and 48% boys. The mean
ranks of SFBT, recognition, recall and PMT are given in Table 2.

**Table 2**

<table>
<thead>
<tr>
<th>Cognitive Functions</th>
<th>NBWNS</th>
<th>NBWS</th>
<th>LBWS</th>
<th>LBWNS</th>
<th>( \chi^2 )</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance IQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFBT - Shortest Time</td>
<td>57.66</td>
<td>68.25</td>
<td>65.73</td>
<td>54.00</td>
<td>3.085</td>
<td>0.379</td>
</tr>
<tr>
<td>SFBT - Total Time</td>
<td>58.23</td>
<td>68.15</td>
<td>62.83</td>
<td>56.76</td>
<td>1.869</td>
<td>0.600</td>
</tr>
<tr>
<td>Planning Performance</td>
<td>Porteus Maze Test</td>
<td>60.59</td>
<td>56.75</td>
<td>61.93</td>
<td>68.02</td>
<td>1.652</td>
</tr>
<tr>
<td>Memory Performance</td>
<td>Recognition - Correct Responses</td>
<td>67.03</td>
<td>51.23</td>
<td>60.20</td>
<td>67.20</td>
<td>4.140</td>
</tr>
<tr>
<td></td>
<td>Recognition - Incorrect Responses</td>
<td>55.97</td>
<td>71.77</td>
<td>62.80</td>
<td>55.80</td>
<td>4.140</td>
</tr>
<tr>
<td></td>
<td>Recall - Correct Responses</td>
<td>56.22</td>
<td>65.17</td>
<td>55.38</td>
<td>72.26</td>
<td>4.469</td>
</tr>
</tbody>
</table>

**Performance IQ** – No statistical differences were seen in the shortest and the total time taken to complete SFBT in the four groups. The mean rank of the children in the LBWNS group was the lowest followed by NBWNS, LBWS and NBWS. The LBWNS group took the least time to complete the test while the NBWS group took the maximum time to complete the test.

**Memory performance** – No statistical differences were seen in the scores of the four groups for recognition and recall. In the recognition test, the mean rank of the correct responses was the highest in the LBWNS group, closely followed by the NBWNS group. The NBWS group gave the least correct responses. The LBWNS children had the highest mean rank for correct recall responses. They were followed by NBWS, NBWNS and LBWS groups.

**Planning performance** – No statistical difference was seen in the mental ages of the four groups. The mean rank for the mental ages was the highest for LBWNS group followed by LBWS, NBWNS and NBWS. This means that LBWNS children attained higher mental ages while NBWS children performed poorly as compared to the other groups.

**Thinking Performance** – The performance of the children was compared across the
four groups using Chi-square test (Figure 1). There was no difference in the performance of the children in the four groups ($\chi^2 = 12.702$, $p = 0.177$). However, of those who used a single concept, maximum children belonged to the NBWNS group followed by NBWS, LBWS and LBWNS. Equal proportion (~ 30%) of children from NBWNS and LBWS used two concepts to sort the blocks. Four children from NBWS, three from LBWS and one from LBWNS were unable to apply any concept. Only one child from the LBWNS group was able to use three concepts.

![Chart showing the number of children in each group using different numbers of concepts.](chart.png)

Fig. 1 Comparison of the Number of Concepts used in the HKCFT by the Four Groups

**Mediating Factors** - A couple of factors may be responsible for these findings (Table 3). Half the NBWS children had per capita income < Rs 2000 per month while more than two-thirds of the LBWNS group had per capita income > Rs 2000 per month. Also, over 50% of the NBWS children attended the *anganwadi* alone while almost 80% of the LBWNS attended formal school in addition to the *anganwadis*. These factors could have influenced the performance of the children in the various tests.

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per Capita Income and Anganwadi/School Attendance of the Four Groups</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Per Capita Income</strong></td>
</tr>
<tr>
<td>&lt; Rs 1000</td>
</tr>
<tr>
<td>Rs 1000 – 2000</td>
</tr>
<tr>
<td>&gt; Rs 2000</td>
</tr>
<tr>
<td><strong>Anganwadi/School Attendance</strong></td>
</tr>
<tr>
<td>Only Anganwadi</td>
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<td>Both</td>
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Influence of Birth Weight and Stunting on Selected Cognitive Functions of Young Children in Low Socioeconomic Areas of Mumbai City

DISCUSSION

In this study, birth weight did not appear to influence the cognitive functions of the children. Stunted children, irrespective of their birth weight performed poorly than the non-stunted ones but, the differences were non-significant.

Literature suggests that cognitive functions may be adversely affected in VLBW (< 1.5 kg) and/or very preterm (< 28 weeks of gestation) children. Such children had lower volumes of cerebral cortex, cerebellum, hippocampus and corpus callosum (Tolsa et al., 2004; Lodgeskensky, Seghier, Warfield, Tolsa, Sizonenko & Lazeyras, 2007; Skranes, Lohaugen, Martinussen, Høberg, Brubakk, & Dale, 2013). In the present study, very few were VLBW and none were very preterm. This may explain the lack of significance in the cognitive functions between LBW and the NBW groups. Besides these, the small sample size could also be responsible for the lack of significance in the statistical tests.

Deficits though not significant, were seen in the NBWS and LBWS groups. The NBWS and LBWS performed poorly in SFBT than the NBWNS and LBWNS. SFBT reflects function like visuo-motor, visuospatial and speed. The NBWS and LBWS also scored lower in planning and memory performance than the non-stunted groups.

These deficits can be explained by two mechanisms – direct and indirect. Firstly, long-term undernutrition especially during the critical period directly affects the optimum development of the different brain structures – cortex, hippocampus and cerebellum. Disturbances in the levels of the neurotransmitters have also been noted (Strupp & Levitsky, 1995). Secondly, undernutrition results in lack of energy leading to poor motor development and subsequently low activity levels. It also causes apathy and lack of interest in the surroundings. Due to this, undernourished children tend to withdraw themselves from their peers and objects in the environment. Also, parents and caregivers tend to be less stimulating towards an apathetic child. This phenomenon was termed as functional isolation (Grantham-Mcgregor, Fernald & Kavita, 1999). Chronic undernutrition results in changes in emotional reactivity and motivation. Undernourished children exhibit higher emotionality, anxiety, increased sensitivity to aversive reinforcement, aggression, impulsiveness, inattention and cognitive inflexibility (Strupp & Levitsky, 1995). In the present study too, stunted children were found to be easily distracted and less attentive. As a result, they took longer duration to complete the SFBT. Also, they were also seen to be impulsive and therefore, made more mistakes than the non-stunted children in the Porteus Maze test, memory tests and concept formation test. Thus, malnutrition may result in behavioural inconsistencies which are conducive for optimal cognitive development.

Poverty has been noted to have a significant impact on cognitive stimulation. Many resources for cognitive stimulation have to be purchased such as toys, games and books. Poverty also influences the physical environment at home, linguistic...

environment, the mother’s involvement with the child and stress (Guo & Harris, 2000; Noble, Houston, Kan, & Sowell, 2012). Further, formal schooling stimulates cognitive development. Thus, per capita income and formal education are likely to be mediating factors that influence cognitive functions of children.

CONCLUSION

Early chronic malnutrition can affect certain cognitive functions and may have long lasting effects on work productivity. This could be because lack of intrinsic motivation. Prolonged malnutrition results in a learned mode of interacting with the environment. Thus the tendency to effectively engage or interact with the environment will have to be explicitly taught to these children.

Strategies to promote optimal cognitive development should be multidimensional. Efforts to prevent chronic undernutrition need to focus on adequate nutrition and health care of pregnant women and their children during the initial years of life. Adequate stimulation with healthy home environment, involvement of parents and formal education are equally necessary for optimal cognitive development.

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Use of Composite Index of Anthropometric Failure as a Measure to Assess the Magnitude of Undernutrition in the Slums of Mumbai

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Abstract:

Background: In India, almost 54% of the deaths under the age of five years are related to malnutrition. Undernutrition is determined by using indicators – underweight, stunting and wasting. These conventional indicators reflect different facets of nutritional status. However, they fail to depict the overall magnitude of undernutrition in the population. Hence, the present study was conducted with an aim to determine the overall magnitude of undernutrition in the slums of Mumbai using Composite Index of Anthropometric Failure (CIAF).

Method: Three hundred children aged between 2 to 4 years were selected from anganwadis located in the western suburbs of Mumbai. Weight and height measurements were taken. Z scores were computed for weight-for-age, height-for-age and weight-for-height using WHO Anthro software. Children were classified in to the conventional index and CIAF (Nandy et al, 2005). Frequency distribution and chi-square test was carried out to analyze the data.

Results: In the study group, 32% children were underweight, 29.5% were stunted and 18% were wasted. According to CIAF classification, 58% children had no form of failure whereas 42% children had at least one form of anthropometric failure. In addition to this, 28.67% of the children had more than one form of anthropometric failure. About 89.5% children (n=86) classified as underweight were also found to be either stunted or wasted or both.

Conclusion: CIAF can be used as a useful tool to determine the magnitude of overall undernutrition. Moreover, it also aids in assessing the prevalence of multiple anthropometric failures in a group. Underweight is most often used nutritional status indicator. This study reveals that using underweight as a sole indicator may underestimate the overall prevalence and severity of undernutrition in a group.
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Weight Change Standard Deviation and Body Fat of 2 to 4 year old Children in the Slums of Mumbai

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**Background:** Disproportionate fat gain during postnatal catch-up growth (CUG) is believed to programme the future metabolic risk. We therefore conducted a cross-sectional study to examine the weight change standard deviation (SD) and body fat in young children belonging to lower socioeconomic background.

**Methods:** We selected 1205 children aged 2 to 4 years from anganwadis located across Mumbai. Weight, height, waist circumference and skinfold thicknesses were measured. Z scores were computed for the anthropometric indices using WHO Anthro software. Slaughter’s equation was used to derive the percent body fat. Waist-height ratio (WHtR) was calculated. Weight change SD was the difference in SD between the current weight and birth weight. One-way ANOVA and multiple stepwise regression were used for statistical analysis.

**Results:** Overall, 40% children had catch-down growth (CDG) and 23% had CUG. Children with CUG were heavier, taller and had a higher BMI than those with no weight change and CDG (p < 0.001). Girls and not boys, with CUG had higher body fat than the CDG (p < 0.001). Among the CUG group, 53% had low birth weight (LBW) and 47% had normal birth weight (NBW). CUG-LBW children had significantly lower weight, height and body fat than the CUG-NBW (p < 0.001). No differences were seen their waist circumference and WHtR. Birth weight Z, weight change SD, age and female gender significantly predicted 13.6% of the variation in the body fat.

**Conclusion:** Only girls with CUG had higher body fat than those with CDG. CUG-LBW children had significantly lower body fat but similar waist circumference and WHtR as the CUG-NBW. There might be a preferential central fat deposition in children who experience CUG after fetal growth restriction. Thus, children in lower socioeconomic strata born LBW followed by CUG are likely to show early signs of central adiposity.

Key words: Weight change SD, catch-up growth, percent body fat, waist circumference, WHtR, low birth weight