Plot and see! Maternal comprehension of growth charts worldwide

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Summary

Objective To evaluate maternal comprehension of growth charts used in growth monitoring and promotion (GMP), a worldwide programme with important budgets but contrasting results.

Methods Systematic literature review through MEDLINE, POPLINE, Global Health, ERIC and the Cochrane Library with the keywords ‘growth monitoring’ or ‘growth chart’ limited to the title/abstract field and to the 0–5 years age range.

Results Twenty studies from Asia (8), Africa (8) and Latin America/Caribbean (3) were included in the review. The results of the 14 non-intervention, cross-sectional studies provide convincing evidence that a third to three-fourths of carers in developing countries do not understand the growth charts. Literacy had a strong effect on women’s ability to interpret the cards. Appropriate training and educational activities also increased substantially maternal comprehension as demonstrated in five of the six intervention trials.

Conclusions Many carers have poor comprehension of growth charts, but their comprehension increases not only with literacy, but also with training. Activities aimed at improving communication skills of health staff and at empowering parents to practice responsive parenting could greatly improve GMP outcomes.

Keywords growth charts, comprehension, maternal education, programme theory, communication, review

Introduction

Research on the determinants of growth, including the relationships between growth and nutrient intake, as well as research to establish the significance of growth as a measure of child well-being, made impressive strides during the 20th century. The development of practical tools to measure and monitor growth (e.g. visual growth charts, simple weighing and measuring techniques) opened the door for the application of this knowledge in public health (Ruel 1995). Establishing the scientific basis for universal growth standards, the acceptance of these standards by national governments, international agencies and NGOs, and the availability of practical tools, provided the foundation for growth promotion programmes based on growth monitoring (de Onis et al. 2004).

The human resources and economic investments that have been expended to build current knowledge about the biological basis for growth monitoring programmes have been substantial. The overwhelming evidence concerning the role of undernutrition in poor growth has been so persuasive that programmes to address it have become nearly universal in countries where undernutrition constitutes an important health problem. Consequently, the resources that have been invested in setting up and sustaining growth promotion programmes are also considerable (Hossain et al. 2005). In contrast to the magnitude of investments in research to generate biological knowledge about growth there has been little investment in research on the delivery and use of growth monitoring and promotion (GMP) programmes. As a consequence, there is a lack of a strong ‘programme theory’ that can serve as the basis for establishing and sustaining effective programmes to promote adequate and appropriate child growth, not only for programmes to prevent growth faltering, but, increasingly, for programmes to prevent obesity. The research that is reported here is part of a larger project to develop programme theory in the area of growth promotion in developing countries (Roberfroid et al. 2005a,b).

The concept of ‘programme theory’ refers to the specification of the mechanisms through which a programmatic intervention is supposed to result in an outcome (or set of outcomes). In their influential book on evaluation, Rossi et al. (2004) define it as follows: ‘the conceptualization of
the program [is] its plan of operation, the logic that connects its activities to the intended outcomes, and the rationale for why it does what it does.’ (p. 44).

The basic logic of programme theory for growth promotion programmes that use growth monitoring as a component can be diagrammed as in Figure 1. Inputs are elements necessary for the implementation of the intervention. Processes include all the actions that lead from inputs to outcomes. Outputs are the immediate results of actions, while Outcomes are the desired changes induced by the project. Assumptions are external factors that are beyond the control of project activities, but which are presumed to be essential for effectiveness, so that they must be verified for a project to be successful (Lefèvre et al. 1999).

In theory, for a programme to achieve its goals, every step in the sequence needs to be in place as a failure at any one step obviates the programme theory and compromises the outcome. On the other hand, if the theory is incorrect in its specification of the steps or mechanisms, programmes may succeed (or partially succeed) despite poor adherence to the model. Impact evaluations of growth promotion programmes that examine only the endpoint, but none of the steps that link the intervention to the endpoint can tell us only whether the goal was or was not achieved (Robert et al. 2006). When it was not achieved, they provide no insight into why or how it failed (Ruel et al. 1992; Karim et al. 1994; de Souza et al. 1999; Hossain et al. 2005; Ross & English 2005). Was the causal model fundamentally wrong? Were there problems in the delivery of the intervention, and if so, at what points and why? Were there failures in the utilization by families? For programmes that achieved their goal when other, apparently similar programmes have failed, impact evaluation without examination of the steps dictated by programme theory do not provide guidance on how to improve less successful ones, or how to revise the programme theory to better specify the mechanisms (Shekar & Latham 1992; Qazi et al. 2002).

![Figure 1](image-url) Programme theory: basic components for a growth monitoring programme to promote child growth through nutrition counseling. The various components of the programme theory are categorized as inputs, processes, outputs and outcomes, and shown in the boxes. Assumptions, both programmatic (light grey) and theoretical (dark grey), are shown in circles.
This paper is concerned with a specific aspect of the programme theory of GMP: the maternal comprehension of growth charts. This specific aspect is part of one of the largest components of the theory, an aspect that can be characterized as the ‘communication component’. Our intent in this paper is not a comprehensive review of all the elements of communication in the linkage between programme delivery and family utilization, but an examination of one part of the larger theory. In GMP programme theory, growth charts and the process of charting have multiple functions that contribute to its effectiveness as an educational and promotional tool. It is intended to make child growth apparent to both health workers and carers. It is expected that it will initiate a communication process that serves to reinforce carers’ current actions when growth is normal, or leads, ultimately, to an improvement in caring practices if growth is unfavourable (WHO 1986; Griffiths 1988; Morley & Woodland 1988; Nabarro & Chinnock 1988; Rohde 1988; Dixon 1991; Fagbule et al. 1991; Ruel 1995; Lotfi 1997). Thus, it is intended as a tool for enhancing the dialogue between carers and health workers as well as a tool to facilitate and motivate carer behaviour change. Its purported functions in relation to mothers and other carers depend on their comprehension of the chart, and creating charts that are understandable has been the subject of considerable programme development activity. In this study we set out to examine what is known about maternal comprehension of growth charts by undertaking a systematic literature review.

Methods

To obtain the database for the literature review we conducted a keyword search of electronic data bases. Specifically we search MEDLINE, POPLINE, Global Health, ERIC and the Cochrane Library with the keywords: ‘growth monitoring’ or ‘growth chart’. The search was limited to the title/abstract field and to the 0–5 years age range. Articles retrieved through the electronic search were screened to assess if they met the inclusion criterion. The unique inclusion criterion was: original studies (i.e. no opinion papers, editorials, or comments) evaluating the understanding of the growth chart by mothers/carers. The bibliography of the relevant articles retrieved was also scrutinized. This procedure was applied two times independently, and the resulting lists of included papers were compared to assess thoroughness of the search. There were no restrictions on settings, language or methods.

Studies that met the inclusion criterion was read thoroughly and then coded for a number of characteristics (variables), including geographic location, research design, sample size, methods used to assess comprehension, scoring system, findings, etc.

The next step was to create a matrix with the studies as rows and the variables in columns. The number of studies in the matrix was sufficiently small that computer-assisted analysis was unnecessary, so analysis proceeded with hand tabulation through an iterative process in order to fully exploit the information contained in the study reports. We then appraised and reported the studies’ quality.

Results

Our search yielded 304 references, 20 of which met the inclusion criterion (Tables 1 and 2), i.e. they specifically measured understanding of the growth chart by mothers/carers. Asia (8), Africa (8) and Latin America/Caribbean (3) are all represented. There were no studies from Europe or North America. Cross-sectional designs were the most common (14 of the 20), with clinic samples predominating over community-based samples (12 of the 20). Our search produced six studies in which the investigators mounted a trial to test whether comprehension could be improved with an educational intervention. These intervention trials used control groups, with pre- and post-intervention evaluation of carer comprehension. One ecological study also included control villages (Hughson et al. 1988).

Although the range of sample sizes was large – from a low of 30 to a high of 2300, the median values, generally several hundred, reflect the sample sizes in the majority of the investigations.

There is variability across the studies both in the selection of outcome indicators of comprehension and in the level of detail that investigators report in their publication. However, the scoring system used by investigators is quite consistent across the studies. Nearly all used test cards to assess carers’ comprehension of growth charts. The number of test cards varied between 2 and 6, with most studies using at least 3. A clear presentation of the method can be found in a McAuliffe et al. (1993).

There are also differences in how authors report the results. These comprise two main categories: (1) some investigators report mean test scores, based on indices developed from the cards; (2) others report the proportion of mothers responding correctly to one or more indicators of comprehension. The differences in how outcomes are reported make it more difficult to characterize levels of carer comprehension performance in relation to specific outcome indicators.

With respect to the indicator ‘proportion of carers who meet comprehension criteria’, which was employed in cross-sectional surveys and in reporting results for the control groups in intervention trials, the values exceed...
Table 1 Controlled trials

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Year</th>
<th>Setting</th>
<th>Intervention</th>
<th>n</th>
<th>GC Outcome</th>
<th>Intervention group</th>
<th>Control group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ghana</td>
<td>1993</td>
<td>Community</td>
<td>Use of DRS within homestead groups (two villages) vs. standard dial scales handled by medical team (one village)</td>
<td>79</td>
<td>Selecting the GC with an ascending growth curve when asked 'Which chart would you choose for your child?'</td>
<td>100% (38/38)</td>
<td>35% (14/41)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2</td>
<td>Kenya</td>
<td>1994</td>
<td>Community</td>
<td>Use of DRS within homestead groups vs. standard dial scales handled by medical team</td>
<td>138</td>
<td>Mothers identifying growth curves as normal or abnormal 12 months after entering the GMP programme</td>
<td>95% (53/56)</td>
<td>40% (33/82)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3</td>
<td>South Africa</td>
<td>1998</td>
<td>Hospital (convenience sampling)</td>
<td>Educational game to help the learning of DRS vs. no game</td>
<td>30</td>
<td>Answering six questions by pointing to one of three test charts *</td>
<td></td>
<td></td>
<td>&lt;0.001$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ante 2.1 Post 1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Papua New Guinea</td>
<td>1984</td>
<td>MCH Clinics</td>
<td>Individual training about 'good' and 'not good' weight graphs vs. no training</td>
<td>142</td>
<td>Accuracy in identifying test charts* as 'good' or not 'good' (baseline and 4 months)</td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ante 3.1 Post 2.9</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mother able to classify her own child growth chart as 'good' or not 'good'</td>
<td></td>
<td></td>
<td>NS†</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ante 82% Post 76%</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>Lesotho</td>
<td>1990</td>
<td>PHC clinics (9)</td>
<td>Training on the RTH chart (318) vs. no training (356)</td>
<td>674</td>
<td>Mother's interpretation of 3 charts at baseline and 3 months after training (mean score, max = 6)!,*</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ante 1.8 (SD 0.1) Post 3.6 (SD 0.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sri Lanka</td>
<td>1997</td>
<td>Clinic</td>
<td>Use of RTH vs. a revised chart</td>
<td>932</td>
<td>Comprehension score of at least 4* Modified chart RTH chart Modified chart + education</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Modified chart 62% (324/519) RTH chart 21% (85/413) Modified chart + education 90% (292/324)</td>
<td></td>
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</tr>
</tbody>
</table>

DRS, Direct Recording Scale; RTH, Road-to-Health chart.

*Test charts are growth curves that depict different nutritional situations of fictitious children. Weights are plotted on real charts. Mothers are asked to interpret the charts and to answer questions by identifying the corresponding charts. 1 point is given for each correct answer and 0 for each incorrect or uncertain answer. Scores of 0–2 were considered 'poor comprehension', a score of 3 'satisfactory comprehension', and 4 or 5 'good comprehension'.

†For the training effect.

§Results for the Road to Health Chart, which is the most commonly used model worldwide.

¶Paired t-test for the increase in knowledge in the intervention group.

1, (Brown & Morley 1993); 2, (Meegan et al. 1994); 3, (Sohal et al. 1998); 4, (Forsyth 1984); 5, (Ruel et al. 1990); 6, (Senanayake et al. 1997).
### Table 2 Cross-sectional studies

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Year</th>
<th>Setting</th>
<th>Subjects</th>
<th>n</th>
<th>GC</th>
<th>Outcome</th>
<th>Results</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kenya</td>
<td>1999</td>
<td>Community</td>
<td>Family members of participants in study followed up 2–3 years after study n‡‡</td>
<td>491</td>
<td>6</td>
<td>Excellent maternal knowledge†</td>
<td>36% (79/219)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Brazil</td>
<td>1993</td>
<td>Community</td>
<td>Mothers of children with at least 1 measurement in the last 12 months</td>
<td>142</td>
<td>6</td>
<td>Understanding the chart* Literate (n = 78) Illiterate (n = 64) At least 4 GC correctly interpreted</td>
<td>4.5 (SD 1.4) 3.2 (SD 1.8) 85% (66/78) 53% (34/64)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3</td>
<td>Saudi Arabia</td>
<td>1995</td>
<td>Clinic</td>
<td>All mothers visiting an urban health center during 8 days</td>
<td>57</td>
<td>4</td>
<td>A flattening or decreasing curve considered concerning * Correct classification of a curve parallel to percentiles outside NCHS standard</td>
<td>49% (28/57) 47% (27/57)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Afghanistan</td>
<td>1986</td>
<td>Clinic</td>
<td>Mothers having attended at least 4 GMP sessions</td>
<td>751</td>
<td>1</td>
<td>Mothers recognizing better child growth and abnormal growth chart at month 6 Comprehension score (0 to 7)** Literate (n = 75) Illiterate (n = 676)</td>
<td>62% (467/751) 3.5 (SD 2.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>1990</td>
<td>Community</td>
<td>Mothers of children 0–6 years, in 38 villages randomly selected</td>
<td>2300</td>
<td>3</td>
<td>Comprehension score of at least 2*</td>
<td>1% (23/2300)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Bahrain</td>
<td>2001</td>
<td>Clinic</td>
<td>Mothers attending MCH clinics in 18 health centers</td>
<td>472</td>
<td>1</td>
<td>Ability to read the information Low education High education Ability to answer all seven questions about the growth card correctly †</td>
<td>16% (17/104) 69% (163/237) 43% (85/198)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>7</td>
<td>Bangladesh</td>
<td>1994</td>
<td>Community</td>
<td>Mothers of an under two kid in eight villages</td>
<td>198</td>
<td>1</td>
<td>Correct combination of 4 weight curves and corresponding pictures * Normal growth Progressive growth retardation Understanding of the markings on the chart; detect growth faltering</td>
<td>53% (106/199) 37% (74/199) 34% (174/518)</td>
<td></td>
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<tr>
<td>8</td>
<td>Somalia</td>
<td>1990</td>
<td>Community</td>
<td>Mothers of all children under 5 years in two villages</td>
<td>199</td>
<td>4</td>
<td>Ability to interpret growth charts§ Good (score 5) Very good (score 7)</td>
<td>18% (158/875) 42% (371/875)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Nigeria</td>
<td>1990</td>
<td>Clinic</td>
<td>Mothers from three communities having attended one health facility in the last 6 months (proportional allocation)</td>
<td>518</td>
<td>1</td>
<td>Ability to interpret growth charts§ Good (score 5) Very good (score 7)</td>
<td>18% (158/875) 42% (371/875)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Ghana</td>
<td>1992</td>
<td>Clinic</td>
<td>Mothers attending various child welfare clinics</td>
<td>875</td>
<td>3</td>
<td>Ability to interpret growth charts§ Good (score 5) Very good (score 7)</td>
<td>18% (158/875) 42% (371/875)</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Country</td>
<td>Year</td>
<td>Setting</td>
<td>Subjects</td>
<td>n</td>
<td>GC</td>
<td>Outcome</td>
<td>Results</td>
<td>P-value</td>
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<tr>
<td>11</td>
<td>Dominica</td>
<td>1983</td>
<td>Clinic</td>
<td>Adults consecutively consulting a child welfare clinic</td>
<td>51</td>
<td>4</td>
<td>Ability to recognize curve with loss of weight as worrying*</td>
<td>53% (27/51)</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Ability to recognize flat curve as worrying</td>
<td>51% (26/51)</td>
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<td>12</td>
<td>St. Lucia</td>
<td>1983</td>
<td>Clinic</td>
<td>Adults accompanying every 3rd child in 26 health centers (systematic random sampling)</td>
<td>460</td>
<td>2</td>
<td>Ability to recognize normal growth curve</td>
<td>37% (169/460)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ability to recognize decreasing curve</td>
<td>38% (175/460)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Bangalore</td>
<td>1993</td>
<td>Home visits</td>
<td>Unclear sampling</td>
<td>156</td>
<td></td>
<td>Correct interpretation of a flattening growth curve</td>
<td>4% (6/156)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Thailand</td>
<td>1988</td>
<td>Community</td>
<td>Mothers from two villages with a health and nutrition project vs. 2 control villages</td>
<td>126</td>
<td>6</td>
<td>All test charts identified correctly*</td>
<td>&lt;0.01</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td>In two villages with a nutrition project</td>
<td></td>
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<td>In two villages without the project</td>
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<td></td>
<td></td>
<td></td>
<td>Identify their own children’s growth curves</td>
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</tbody>
</table>

*Test charts are growth curves that depict different nutritional situations of fictitious children. Weights are plotted on real charts. Mothers are asked to interpret the charts and to answer questions by identifying the corresponding charts. 1 point is given for each correct answer and 0 for each incorrect or uncertain answer. Scores of 0–2 were considered ‘poor comprehension’, a score of 3 ‘satisfactory comprehension’, and 4 or 5 ‘good comprehension’.

†Excellent knowledge’ means: no hesitation in understanding charts including interpreting sharp fluctuations and changes; knowing appropriate actions to take if child is not growing adequately; understanding key messages from the chart on breast feeding, nutrition and diarrhoea.

§That is the only significant difference between the two groups.

††Mothers rated ‘very good’ if: a. was aware that the dots on the card represented her child’s monthly body weights; b. could identify the dot representing her child’s weight for that day; c. could identify increase, decrease, and stagnation in the child’s body weight on the chart; d. related faltering growth to reduced intake of good food and/or improper parental care; e. identified faltering growth in cases A and C and pointed to the continuous progress in weight in case B; f. chose cases reflecting her desire for a healthy, growing child; g. was very confident in her choices. Mothers were rated ‘good’ if only criteria a through e were satisfied.

*(1) On which part of the card should your baby’s weight be for you to know that he is growing well? (2) Which part is bad? (3) What happens if the weight mark falls below the green belt? (4) What happens if the weight mark is in the green belt? (5) What happens if the weight mark is above the green belt? (6) What does it mean if the present month’s weight is more than the previous month’s? (7) What if the present month’s weight is less than the previous month?

**knowing the purposes of the chart (2 points); purpose of weight marks; purpose of upper line; purpose of lower line; purpose of space; ability to tell better weight for child. 1, (Meegan & Morley 1999); 2, (McAuliffe et al. 1993); 3, (Rasheed et al. 1996); 4, (Grant & Stone 1986); 5, (Gopaldas et al. 1990); 6, (Musaiger & Abdulkhalek 2001); 7, (Karim et al. 1994); 8, (Morley 1994); 9, (Fagbule et al. 1990); 10, (Owusu & Larrey 1992); 11, (Wit et al. 1984); 12, (Owen & Owen 1983); 13, (Vasundhara & Harish 1993); 14, (Hughson et al. 1988).
provide further information (Hughson 1988; Musaiger & Abdulkhalek 2001). The results provide strong evidence about the positive effect of educational activities designed to improve carer comprehension. Five of the six studies found significant improvements in comprehension with an educational intervention. The one study that failed to show an improvement, a trial in Papua New Guinea, had such high rates of initial comprehension in both the intervention and control groups prior to the intervention (above 80%) that there was little opportunity to show an impact. Column 3 shows the levels of comprehension that were achieved after the intervention, based on the comprehension criteria the studies used. The 4th column reports the estimated proportion of improvement. These are shown either as the proportion of carers who improved or the proportionate improvement in scores, depending on which type of outcome the investigators used and reported. Improvements in performance with an educational intervention ranged from 30% to 65%. Thus in studies where the initial performance levels were very low (as was the case in Sri Lanka) they rose to 62%, and in studies where initial performance was above 50% (as in Ghana and Kenya) it rose to nearly 100%.

**Discussion**

The results of the 14 non-intervention, cross-sectional studies provide convincing evidence that many carers in developing countries do not understand the growth charts used by the growth monitoring programmes in which they participate. In some of the studies, less than a fourth of the women met the comprehension criteria established by the investigators. Even in studies with better outcomes the proportion of women who could provide correct answers was less than two-thirds. This raises fundamental questions about the role of growth charts in growth promotion: is the programme theory wrong? Alternatively, ‘is the theory correct?’, and the findings from the studies provide part of the explanation for why programmes are less successful than they are expected to be.

The studies that differentiated the sample by levels of literacy or education were consistent in documenting the strong effects of more education on women’s ability to interpret the cards. This finding suggests that the efforts to create charts that are understandable without reading skills have not been as successful as has often been assumed. In view of the fact that better maternal education and literacy is generally associated with better child growth, even when the effects of higher socio economic status (SES) are taken into account, another implication of this finding is that the women who are more likely to have malnourished children are also more likely to have difficulties comprehending the growth charts. Moreover, the effect of literacy is important not only for maternal comprehension of the charts, but also, as reported in two of the studies, for perceiving that the charts are useful (Hughson et al. 1988; Musaiger &

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Year</th>
<th>Significant improvement from pre-intervention</th>
<th>% carers with correct comprehension post-intervention</th>
<th>Estimated proportion improvement from incorrect to correct after intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ghana</td>
<td>1993</td>
<td>Yes ($P &lt; 0.05$)</td>
<td>100</td>
<td>65% of carers</td>
</tr>
<tr>
<td>2</td>
<td>Kenya</td>
<td>1994</td>
<td>Yes ($P &lt; 0.05$)</td>
<td>95</td>
<td>55% of carers</td>
</tr>
<tr>
<td>3</td>
<td>South Africa</td>
<td>1998</td>
<td>Yes ($P &lt; 0.001$)</td>
<td>Not available</td>
<td>52% mean increase in knowledge score†</td>
</tr>
<tr>
<td>4</td>
<td>Papua New Guinea</td>
<td>1984</td>
<td>No (ns)</td>
<td>83</td>
<td>3% mean loss in knowledge score</td>
</tr>
<tr>
<td>5</td>
<td>Lesotho</td>
<td>1990</td>
<td>Yes ($P &lt; 0.001$)</td>
<td>33–75*</td>
<td>30% mean increase in knowledge score†</td>
</tr>
<tr>
<td>6</td>
<td>Sri Lanka</td>
<td>1997</td>
<td>Yes ($P &lt; 0.001$)</td>
<td>62</td>
<td>41% of carers</td>
</tr>
</tbody>
</table>

*Depending on type of problem assessed.
†The percent increase is calculated relative to the maximum score, i.e. [(% maximum score) post- (% maximum score) ante].
Abdulkhalek 2001). The duration of schooling rather than literacy per se seems to be important (Gopaldas et al. 1990; Senanayake et al. 1997; Musaiger & Abdulkhalek 2001). It is probable that the significance of literacy goes beyond comprehension and may be a marker for other characteristics that facilitate behaviour change. Robert et al. (2006) suggest that literacy enables a more egalitarian dialogue with the health staff, which, in turn, facilitates the process of integrating the recommendations and translating them into actions. In other words, mother literacy could allow a better general management of child health through various paths, and the comprehension of the growth chart itself might be one element among several.

In contrast to the cross-sectional studies, the intervention trials which taught mothers how to use and interpret the charts present a very different picture. In five of the six trials we reviewed, the improvements in maternal comprehension were not only statistically significant; they were also substantively significant in the magnitude of change. Differences in the outcome measures reported by investigators make it difficult to summarize the magnitude of effect of the educational interventions, but it is clear from the studies that they were able to bring about substantial changes in the proportions of carers who understood the charts and/or their amount of knowledge.

Even more striking is the finding that the relationship between literacy and comprehension disappears in the two studies in which mothers benefited from intensive nutrition education and training (Hughson et al. 1988; Aden et al. 1990). This is an important finding because it implies that the communication style that is often defined as ‘patient-centredness’ is also central to growth promotion (Mead & Bower 2000). Although the studies do not report their procedures in detail, it is likely that the interventions that achieved excellent results in improving comprehension did so through a process that was characterized by adherence to principles of adult learning. Evidence from the Santa Lucia study, where respondents’ knowledge of weight-for-age curves appeared to be determined largely by the workload of the clinic nurse, supports that hypothesis (Owen & Owen 1983). Other evidence about the importance of health workers’ communication style, including respect for mothers, is available in more recent studies. For example, in Brazil, Pelto et al. (2004) demonstrated that nutrition counselling training changed physician behaviour and improved carer knowledge acquisition. Observations in clinics showed that the trained physicians included locally appropriate messages in the communication with carers, used tools for assessing individual problems, and developed good counselling skills, including respect and patience in their interactions with mothers. In contrast to the mothers in the control group, which had poor recall of nutrition advice, mothers in the intervention group had high levels of recall of the advice they received. The investigators concluded that this finding provides part of the explanation for the better growth in weight of the children in the intervention group compared with children in the control group (Santos et al. 2001). In a cluster-randomized controlled trial, Penny et al. measured the effectiveness of a good quality nutrition counselling (Penny et al. 2005). Noticeably, one of the messages provided by the health staff to carers was ‘teach your child to eat with love, patience and good humour’. This bio-psychosocial perspective turned out to be very effective.

We hypothesize that education acts as an effect modifier: it facilitates and increases the effect of a genuine communication with health staff. An indication of this is provided in study by Senanayake where the maximum improvement in comprehension score with the introduction of a new type of chart was obtained in the group of more educated women (Senanayake et al. 1997). In Peru also, maternal education level was a predictor not only for carer exposure to counselling, but also for carer key message recall (Robert et al. 2006).

Besides literacy and training, a third mechanism could enhance maternal comprehension: homestead groups. Evidence from three studies tends to support that hypothesis. However, the design of these studies does not permit disentangling the effects of the Direct Recording Scale and of homestead groups (Brown & Morley 1993; McAuliffe et al. 1993; Meegan et al. 1994).

Our review revealed a number of methodological problems that commonly occurred in the comprehension studies. The testing tended to be artificial, providing no possibility for mothers to connect information on the test chart with concrete elements of their experience or relevant observations regarding the child, such as lack of appetite, illness, or behavioural changes. Without that information relating to a specific child, the comprehension evaluation becomes very theoretical. The studies in New Guinea (Forsyth 1984) and Thailand (Hughson et al. 1988) examined both theoretical interpretation of charts and mothers’ assessment of their own child’s nutritional status and found that mothers performed better on the latter than the former.

Additional problems we noted included inadequate description of the study methods and inappropriate or inadequate analytic procedures (Table 4). For example, investigators often failed to use statistical procedures to adjust for confounders or to disaggregate results by personal and social characteristics (parity, age, education, SES) that are likely to influence comprehension. Those study weaknesses make it difficult to assess both internal and external validity of the studies.
Lastly, results of comprehension tests were often reported as aggregated scores. This is misleading as all test charts are considered similar. For instance, test charts showing a flattened curve were particularly difficult for mothers to understand, when GMP is precisely based on the concept of facilitating the identification of such growth pattern (incipient growth faltering). Reporting aggregated scores dilutes that comprehension gradient.

**Conclusions**

The programme theory that gives growth charts and growth charting a central role in growth promotion posits...
several mechanisms for its effectiveness. On one hand, it is supposed to influence health worker performance by initiating and facilitating communication with mothers. On the other hand, it is thought to be important for mothers. With respect to mothers, it is necessary to distinguish the following uses of growth charts for the communication aspects of growth promotion programmes: (1) to help mothers in a community understand concepts of normal and abnormal growth; (2) to help a n individual mother understand that her child is not growing well; (3) to motivate behaviour change.

The results of the studies we reviewed are relatively clear in relation to the first use. They suggest that comprehension is poor unless health workers (or investigators) make specific efforts to help carers understand the charts. They are less instructive in relation to the second because most of them were not designed to address this question. They provide no information on the third use. None of the studies in our database looked specifically at the link between comprehension and motivation for behaviour change. They do not tell us whether carer comprehension of the growth chart is actually a necessary or sufficient condition for responding to counselling. This major gap in the testing of growth promotion programme theory needs to be addressed.

Separate from the issue of whether understanding the growth chart is important for motivating carer behaviour change is the matter of whether the growth chart is important to motivate health workers to counsel mothers. There is growing awareness of the value of improving communication between health workers and families as a means of supporting the potential of educational interventions to reduce the burden of malnutrition, particularly when it is undertaken in tandem with food interventions. Do the growth charts have a role in improving the attitudes of health staff about nutrition problems and effective counselling? This important question is outside the scope of our review, and needs to be addressed through studies that are aimed specifically at this aspect of growth promotion programme theory.

It is important to place the issue of growth charts within the larger context of programme theory for growth promotion. Improving programmes requires close attention to the process and better programme theory, which can be used to identify bottlenecks and provide guidance on how to overcome them. The research agenda to establish the programme theory for growth monitoring programmes needs to be multifaceted, and requires multi-disciplinary collaborations. There is already a small body of research on some of the issues related to the delivery component of programmes, including: (1) health professionals’ perceptions of growth monitoring and growth promotion programmes and tools (Roberfroid et al. 2005b); (2) front-line health workers’ and health professionals’ nutrition knowledge and nutrition counselling skills (Mitchelman et al. 1990; Freed et al. 1995; Glanz 1997; Loechl et al. 2004); and (3) performance criteria (Gouws et al. 2005; Roberfroid et al. 2005a). These contribute to the development of programme theory for growth promotion related to delivery/health service issues, but further studies are needed.

In addition to investigating whether and how mothers’ comprehension of their children’s growth charts affects nutritional caregiving and behaviour change, the research agenda also includes attention to the other steps in the household utilization components of growth promotion programme theory. Among the topics that require explanation are the factors that affect carers’ recall of nutrition counselling advice (Pelto et al. 2004), the factors that influence motivations and capacity to try out feeding recommendations, and the determinants of sustaining recommended behaviours to the level that is required to attain adequate growth (Dicken et al. 1997).

In conclusion, our review documents the fact that many mothers have poor comprehension of growth charts, but their comprehension increases not only with literacy, but also with training. Low comprehension rates can be considered a symptom of the poor interaction between health workers and carers. Lack of interest and low competency of health staff in growth promotion activities is an acknowledged cause of poor results (Griffiths et al. 1996). This needs to be addressed through activities that are aimed at improving attitudes, skills and the conditions in which health staff work, such as providing training to improve communication and diagnosis skills; enhancing the technical quality of nutrition counselling by providing health workers with appropriate best practice recommendations; and addressing the conditions that disempower frontline health staff. Most of all, it is necessary to develop programmes that empower parents to practice responsive parenting; that support patient-centeredness; that are culturally adapted through processes that bring together viewpoints of families and health workers; and that ensure that carers are accepted as partners through activities that support the sharing of power and responsibility. Sound programme theories and investing in research to develop and test these theories are an essential aspect of achieving these goals.

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Trace et vois La compréhension maternelle des diagrammes de croissance dans le monde

OBJECTIF Evaluer la compréhension maternelle des diagrammes de croissance utilisés dans la surveillance et la promotion de la croissance, un programme mondial avec des budgets importants mais des résultats variables.

MÉTHODES Revue systématique de littérature sur Medline, Popline, Global Health, ERIC, et la bibliothèque de Cochrane avec les mots-clés «surveillance de croissance» ou «diagramme de croissance», limités à la section titre/résumé et pour la tranche d’âge de zéro à 5 ans.

RÉSULTATS 20 études en Asie (8), Afrique (8) et Amérique latine/Caraïbes (3) ont été incluses dans l’analyse. Les résultats de 14 études transversales sans intervention fournissent l’évidence convaincante qu’un tiers à trois-quarts des mères dans les pays en voie de développement ne comprennent pas les diagrammes de croissance. L’instruction a un effet important sur la capacité des femmes à interpréter les diagrammes. Une formation appropriée et des activités éducatives augmentent également substantiellement la compréhension maternelle comme le démontrent 5 des 6 études d’intervention.

CONCLUSIONS Beaucoup de mères ont une compréhension faible des diagrammes de croissance, mais leur compréhension augmente non seulement avec l’instruction mais également avec la formation. Les activités visant à améliorer les aptitudes de communication des agents de la santé et l’habilitation des parents pour la pratique parentale adéquate pourrait considérablement améliorer les résultats de la surveillance et la promotion de la croissance.

MOTS CLÉS diagrammes de croissance, compréhension, éducation maternelle, théorie de programme, communication, revue

Trázalo y lo verás! La comprensión materna de las gráficas de crecimiento a nivel mundial

OBJETIVO Evaluar la comprensión materna de las gráficas de crecimiento utilizadas en la Monitorización y Promoción del Crecimiento (MPC), un programa a nivel mundial con un presupuesto importante pero resultados controvertidos.

MÉTODOS Revisión sistemática de la literatura a través de Medline, Popline, Global Health, ERIC, y la Cochrane Library, utilizando las palabras clave ‘monitorización crecimiento’ OR ‘gráfica crecimiento’ limitadas al campo del título /resumen y con un rango de 0–5 años.

RESULTADOS Se incluyeron 20 estudios de Asia (8), África (8) y América Latina /Caribe (3). Los resultados de 14 estudios crosseccionales no intervencionistas proveen evidencia convincente de que entre un tercio y tres cuartos de los cuidadores en países en vías de desarrollo no entienden las gráficas de crecimiento. El nivel de alfabetización tiene un efecto importante en la habilidad de las mujeres para interpretar las gráficas. Un entrenamiento adecuado así como actividades educativas aumentaron sustancialmente la comprensión materna, tal y como se demostró en 5 de los 6 ensayos intervencionistas.

CONCLUSIONES Muchos de los cuidadores tenían una comprensión pobre de las gráficas de crecimiento, pero esta aumenta no solo con el nivel educativo sino con el entrenamiento. Las actividades orientadas a mejorar la habilidad de los trabajadores sanitarios a la hora de comunicarse, así como a animar a los padres a practicar una paternidad receptiva, podrían ayudar a mejorar considerablemente los resultados de la MPC.

PALABRAS CLAVE gráficas de crecimiento, comprensión, educación materna, teoría de programa, comunicación, revisión