

Do growth monitoring and promotion programs answer the performance criteria of a screening program? A critical analysis based on a systematic review

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Summary

OBJECTIVE Growth Monitoring and Promotion programs (GMP) have been intensively promoted to improve children's health in developing countries. It has been hoped that regularly weighing children would result in the early detection of growth falterers, and that the growth chart would serve as an educational tool to make that state apparent to both health workers and caretakers in order to trigger improved caring practices. Our objective was to review whether GMP answers the theoretical grounds of a screening and intervention program.

METHOD A systematic literature review was performed. The WHO framework developed by Wilson and Jungner for planning and evaluating screening programs guided the analysis.

RESULTS Sixty-nine studies were retrieved. Overall, evidence is weak on the performance of GMP as a screening program for malnutrition through early detection of growth falterers. The main results are: (1) malnutrition remains a public health problem, but its importance is context specific; (2) the value of a low weight velocity to predict malnutrition is unknown and likely to vary in different contexts; (3) the performance of GMP for improving nutrition status of children and in reducing mortality and morbidity is unknown; (4) the performance of the screening is affected by the unreliability of weight measurements; (5) the promotional and educational effectiveness of GMP is low, in particular the growth chart is poorly understood by mothers; (6) the acceptability seems low in regards of low attendance rates; (7) evidence is lacking regarding cost-effectiveness.

CONCLUSIONS We conclude that there is too little scientific evidence to indiscriminately support international promotion of GMP. However GMP could constitute a valid strategy of public nutrition in specific situations. We indicate paths for further research and how prevention programs could be developed.

keywords growth chart, monitoring, screening, promotion, malnutrition, prevention

Introduction

It is acknowledged that malnutrition is an important factor associated with the high under five morbidity and mortality rates observed in developing countries (Pelletier 1994; Schroeder & Brown 1994; Rice *et al.* 2000). Although the leading causes of death are basically of infectious nature, under nutrition and vitamin A or zinc deficiencies are now recognized as immediate underlying causes in direct relation with their prevalence rate (Black *et al.* 2003). As a matter of fact, changes in child survival appear to be strongly associated with changes in malnutrition (Pelletier & Frongillo 2003). Subsequently, great hopes were put in Growth Monitoring and Promotion (GMP) programs to

achieve the goals of the Child Survival and Development Revolution by early detection and prevention of malnutrition (Schroeder & Martorell 1997; Nabarro & Chinnock 1988). However, several authors have pointed out that despite important international efforts, there is little evidence of having achieved these goals (Cape 1988; Nabarro & Chinnock 1988; Dixon 1991; Gerein & Ross 1991; Garner *et al.* 2000). Where most proponents would acknowledge this state of affairs, they rather look at the lack of rigorous implementation of the program guidelines or at the common logistic and financial difficulties all health programs in developing countries face (Grant 1986; Cape 1988; Griffiths 1988; Hendrata & Rohde 1988; Rohde 1988; Dixon 1991; Griffiths *et al.* 1996; Lotfi 1988;

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Chopra & Sanders 1997). Few did question the validity of growth monitoring as a screening test or scrutinized the theoretical grounds of GMP as a screening and intervention program.

The WHO defines GMP as nutrition interventions that not only measure and chart weight of children, but use this information on physical growth to counsel parents in order to motivate actions that improve growth (WHO 1986). The growth chart is meant to detect growth faltering in a child before any observable sign or symptom of malnutrition becomes evident. Making the condition apparent to both the health worker and the mother, the first can advise on early corrective measures that have to be implemented by the latter (Henry *et al.* 1989; Editorial 1992; Thaver *et al.* 1993; Garner *et al.* 2000). In GMP, early growth faltering is detected by regularly measuring and charting children's weight against reference curves (Morley & Woodland 1988; Gopalan & Chatterjee 1989). Following detection, subsequent interventions can range from empowering caretakers by providing social support to supplementing food or referring to curative services according to circumstances and programs. Communication with the caretakers on the basis of the growth curve is always considered the key element. As such, the definition of GMP corresponds to the definition of a screening program. Screening is the presumptive identification of unrecognized, pre-symptomatic, health problems by using procedures which can be applied rapidly, with the idea that early intervention provides more benefits than intervening at a later stage (Wilson & Jungner 1968).

The aim of this paper is to analyze GMP on its merits as a screening program based on the available scientific evidence.

Materials and methods

The WHO guidelines drawn up by Wilson and Jungner consider 10 criteria for judging whether a screening program is appropriate in any particular setting (Wilson & Jungner 1968). The decision on whether to implement the screening program is taken from an overall judgment of the performance on all criteria. In our analysis, for reasons explained in the text, we discuss criteria 2 and 3 together and have added a criterion of coverage (criterion 11).

We did a systematic literature review to collect available evidence for each of the 11 criteria. The search was performed through Medline, Popline, CabHealth, and the Cochrane Library with the following keywords (free text): 'growth' and 'monitoring'; 'growth' and 'chart'. To get more specific evidence on the first criterion, we did a second search using the terms (free text): 'anthropometry' and 'mortality' and 'child'. The bibliography of the

relevant articles retrieved was also scrutinized. There were no language restrictions. In the first search no exclusion criteria were used as the objective was to integrate all the available evidence. In the second search the following inclusion criteria were used: community-based, prospective studies. An appraisal of data quality is given in the text when appropriate.

We acknowledge that an inadequate weight gain velocity* can cover very different nutritional patterns from failure to thrive to emerging acute malnutrition. However these distinctions were not considered relevant to the present discussion which concentrates on the adequacy of GMP to screen for any type of malnutrition through the early detection of a decrease in weight gain velocity. 'Growth retardation', 'growth faltering' and 'malnutrition' are used interchangeably in this paper.

Results

1. The condition being screened for should be an important health problem

In GMP, the condition being screened for is growth retardation through early detection of weight deceleration episodes. It is obviously an important health problem in developing countries. First, the prevalence of malnutrition remains high. Recent estimates report that, although rates vary among countries, 28.5% of children under 5 years of age in Africa and 29.0% in Asia are underweight (ACCSCN 2000). Second, the consequences of malnutrition in terms of child morbidity and mortality are disastrous (Schroeder & Brown 1994; Pelletier 1994; Tomkins & Watson 1989; Rice *et al.* 2000). The association between being underweight [defined by weight-for-age (WA)] and risk of dying of all causes has been documented in 18 prospective community-based studies (Kielmann & McCord 1978; Chen *et al.* 1980; Heywood 1982; Kasongo Project Team 1983; Smedman *et al.* 1987; Lindskog *et al.* 1988; Alam *et al.* 1989; Briend & Bari 1989; Katz *et al.* 1989; Yambi *et al.* 1991; Vella *et al.* 1992; Bairagi *et al.* 1993; Van den Broeck *et al.* 1993; Pelletier *et al.* 1994; Vella *et al.* 1994; Fawzi *et al.* 1997; Garenne *et al.* 2000; Muller *et al.* 2003). The fundamental relationship between malnutrition and death is observed in all the studies, but one (Smedman *et al.* 1987)†. The association is already significant for moderate malnutrition (WA between -3 SD and -4 SD) and seems to follow a

* Weight gain velocity is defined as the gain in weight per time unit. Weight gain velocity is considered adequate if the weight curve of a particular child is parallel to the reference curves.

† Unusual cut-off points were used and the authors invoked a confounding effect by age.

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dose-effect relation, particularly evident in nine studies (Kielmann & McCord 1978; Heywood 1982; Lindskog *et al.* 1988; Alam *et al.* 1989; Katz *et al.* 1989; Yambi *et al.* 1991; Bairagi *et al.* 1993; Fawzi *et al.* 1997; Garenne *et al.* 2000). Thus, considering the huge number of children affected by mild-to-moderate malnutrition, great benefits can be expected from a strategy effective to prevent this stage (Bairagi *et al.* 1985; Pelletier 1994; Schroeder & Brown 1994). Although the presence of risk is consistent among studies, the strength of the association varies largely by setting, being modified by factors such as socio-economic status, general health environment, season, or age range.

2. There should be a detectable early stage & 3. The natural history should be well understood

In GMP, an insufficient weight increment is the early stage that should be detected before the appearance of physical signs, even before the parents notice anything is wrong with their child (WHO 1986; Nabarro & Chinnock 1988; Briend & Bari 1989; Dixon 1991; Thaver *et al.* 1993; Lotfi 1988). However, the early stage concept in malnutrition is particular because it is an unstable condition that can evolve in two directions: a large proportion of children who experience an episode of weight loss will recover and only some will become malnourished.

In Sierra Leone, it was shown that 31.8% of children experience at least one episodes of weight loss between the ages of 12 and 24 months (Hodges 1991). And even in a well-nourished, western populations this proportion amounts to nearly 18% (Martorell & Shekar 1994). So, a decrease in weight gain does not seem *a priori* to be a specific sign of incipient malnutrition. In particular, there is no definition of what the threshold of a weight loss should be, to be considered an early stage. When the definition of the early stage of a disease is blurred, it becomes difficult to describe its natural history. This is why we discuss criteria 2 and 3 from Wilson and Jungner under the same heading.

Only one study addressing the validity of the early stage concept for GMP was retrieved (Henry *et al.* 1989). It showed that weight changes in the previous 3 months were less predictive of current body weight than weight measured at the age of 6 months. However, results were expressed in terms of correlation coefficients and not in terms of risk ratio for specified weight changes.

In five other studies the association between weight gain velocity and mortality was addressed (Bairagi *et al.* 1985; Kasongo Project Team 1986; Briend & Bari 1989; Bairagi *et al.* 1993; Ross & English 2005). In all but one (Ross & English 2005) studies there is a clear association between growth deceleration and the risk of death. Unfortunately

considerations on how mortality risk was influenced by the initial weight for age and by the duration and amplitude of the deceleration were overlooked. Moreover the presence of confounding factors and effect modifiers, such as season (Maleta *et al.* 2003) were not taken into account in the analyses. In a study by Ross and English, neither WAZ nor the rate of WAZ increase from birth to 6-week visit was a good predictor of subsequent death or admission but this could be explained by the selected population (children with a birth weight of 2500 g or more) and the short follow-up.

4. Treatment at an early stage provides more benefit than at a later stage

Treating severe malnutrition is difficult and experience shows that case-fatality rates remain high in most settings (Waterlow 1999). The theoretical benefit of early management of growth deceleration is therefore high in terms of lives saved, and reduction of costs for the health system (Gopalan & Jaya Rao 1984; Bern *et al.* 1997). No reports of experiments comparing efficacy of early *vs.* late intervention have been retrieved, probably because of obvious ethical considerations. Still, the question should be raised whether early management provides any benefits at all. In GMP, the growth chart is expected to serve as an educational and promotional tool that makes child growth apparent to both health workers and caretakers. It is expected that it will trigger a communication process, reinforcing current action when growth is normal, and calling for improvement in caring practices if growth is unfavourable (WHO 1986; Ghosh 1988; Griffiths 1988; Morley & Woodland 1988; Nabarro & Chinnock 1988; Rohde 1988; Briend & Bari 1989; Dixon 1991; Fagbule *et al.* 1991; Msefula 1993; Lotfi 1988; Mapatano *et al.* 1997; Tonglet *et al.* 1999). For this hypothesis to be true, the communication process should result in a better understanding of the growth chart by the caretakers and in more adequate caring practices (process indicators). The final result should be an improved nutritional status of the children (effect indicator).

Process indicators. Twenty-one studies were retrieved concerning the understanding of the growth chart by caretakers (Owen & Owen 1983; Forsyth 1984; Wit *et al.* 1984; Grant & Stone 1986; Hughson *et al.* 1988; Aden *et al.* 1990; Fagbule *et al.* 1990; Gopaldas *et al.* 1990; Ruel *et al.* 1990; Owusu & Lartey 1992; Ruel & Habicht 1992; Brown & Morley 1993; McAuliffe *et al.* 1993; Vasundhara & Harish 1993; Karim *et al.* 1994; Meegan *et al.* 1994; Rasheed *et al.* 1996; Senanayake *et al.* 1997; Sohal *et al.* 1998; Meegan & Morley 1999; MUSAIGER &

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Abdulkhalek 2001). The scoring system based on interpreting test charts was consistent throughout studies. Overall the comprehension scores are quite low, even with charts adapted for illiterates (Morley & Procter 1988; Meegan *et al.* 1994; Morley 1994; Senanayake *et al.* 1997; Sohal *et al.* 1998; Meegan & Morley 1999). Literacy and training sessions seem to improve comprehension scores. Comprehension of growth chart features improved with the literacy level of the mother (Grant & Stone 1986; Gopaldas *et al.* 1990; McAuliffe *et al.* 1993; Senanayake *et al.* 1997; Musaiger & Abdulkhalek 2001).

There were much fewer studies addressing the relationship between the implementation of a GMP program and subsequent changes in caring practices. The few studies reported very discouraging results (Forsyth 1984; Behague 1993). In Lesotho, Ruel *et al.* found small improvements in maternal nutritional knowledge and some indices of modified practices (prolonged duration of breast-feeding) in mothers attending a clinic-based GMP (Ruel *et al.* 1992). But group education, although not directly integrated with GMP, was considered responsible for the positive association between maternal knowledge and clinic attendance. This was confirmed by a crossover trial done in the same population which showed that growth charts only marginally improved maternal learning from nutrition education (Ruel & Habicht 1992). The same conclusion was also reached in Bangladesh (Save the Children UK 2003; Hossain *et al.* 2005).

Effect indicators. Interpreting effect indicators is difficult because usually GMP is part of a full package of preventive services. In important programs known to be successful (Iringa in Tanzania, Tamil Nadu in India), it is not possible to separate benefits due to GMP from benefits due to other components (Pelletier & Shrimpton 1994; Griffiths *et al.* 1996).

A number of studies in Bangladesh, India, South Africa and Brazil show that the nutritional status of participating and non-participating children in GMP was not significantly different. (Gopaldas *et al.* 1990; Ruel *et al.* 1992; Karim *et al.* 1994; de Souza *et al.* 1999; Save the Children UK 2003; Hossain *et al.* 2005)? Only one study reported that children of mothers who correctly interpreted test cards had a better nutritional status, but as stated by the authors the association could be confounded by many factors (Owen & Owen 1983). In another study, a positive association was also found but vanished after adjusting for literacy level (Gopaldas *et al.* 1990). Only one longitudinal study in Pakistan reported an improvement in weight gain in 62% (128/207) of children participating in a GMP

program over a period of 15 months (Qazi *et al.* 2003), but there was no control group.

The most striking piece of information comes from a community intervention trial in India. In this study all families were extensively counselled on health and nutrition of young children during regular home visits. Follow up showed that the growth of all children improved regardless of whether the growth chart was used or not during the counselling sessions (George *et al.* 1993). So, it seems that the chart has no added value for extensive counselling.

5. There should be a suitable test for the early stage

In GMP programs, early slowdown in weight gain is detected through the regular plotting of the weight on the growth chart. No validation studies were retrieved regarding the growth chart as a screening tool for the early stages of malnutrition. But a number of elements do compromise the potential performance of the tool.

First, the international reference (NCHS-WHO) currently used for these charts is not appropriate for breast-fed children (Victora *et al.* 1998; de Onis & Onyango 2003). Breast-fed children grow slower in weight during the first 6-months of life. The consequence is that during this period a higher proportion of these children will be considered malnourished, increasing as such the number of false positive cases.

Second, there is no suitable, internationally agreed cut-off point for the early stage. Based on the association measures with the risk of mortality, there is no clear definition of the early stage in anthropometric terms (as explained under point 2). In other words, sensitivity and specificity of the test cannot be determined.

Finally, the variance of weight measurements as a result of measurement errors (imprecision variance) and of intra-subject weight fluctuations due to physiologic factors (undependability) add to the unreliability of the growth chart as a screening tool (Marks *et al.* 1989). Several studies raised concerns about the unsatisfactory level of precision reached by health workers (careless technique) (Gopaldas *et al.* 1990; Kuhn & Zwarenstein 1990; Dixon 1993; Dixon & Sutton 1994; Kapil *et al.* 1996). Errors occur at various steps (weighing, plotting, age and date reporting) and accumulate (Jelliffe & Jelliffe 1987). Also measurement errors for dynamic indicators can be bigger than for one-time indicators because the former are based on repeated measurements (Briend & Bari 1989). If one considers that – when measured under ideal conditions – the mean monthly weight gain from age 6 to 59 months is between 200 and 400 g it is likely that variations of consecutive weight measurements under field conditions

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will be greater than this range (Briend & Bari 1989; Dixon & Sutton 1994). A strict standardization of measurements would minimize the imprecision variance but might be difficult to obtain under field conditions (Kuhn & Zwarenstein 1990), except maybe in programs engaging important human resources in supervision (Tuan *et al.* 2002). On the other hand, indicators based on measurement of weight changes are very sensitive to transient conditions (Bairagi *et al.* 1985; Bairagi & Chowdhury 1994) such as intake of food or drinks, emptying of bladder or bowels, or dehydration. As a consequence, sensitivity and specificity will be affected by these measurement errors and intra-subject weight variations.

6. The test should be acceptable to the caretakers

Acceptability of the program has not received much attention in the literature. Only one study was retrieved (Faber *et al.* 2003). This qualitative investigation of mothers' perceptions of community-based GMP activities in a rural village in South Africa reported a high acceptance of the project. However, this small-scale project – 329 children intensively followed up over a five-year period – is not representative of most GMP programs worldwide. On the contrary, other reports related to this topic do suggest that acceptance might not be very high.

Using participation rate to the weighing sessions as an indirect indicator, the observation that in many settings compliance drops after completing the immunization schedule, raises questions about the real acceptability of GMP by caretakers (Owusu & Lartey 1992; Msefula 1993; Rasheed *et al.* 1996; Mapatano *et al.* 1997). Another consideration is that participating in consecutive GMP sessions is a time-consuming activity (Lovel *et al.* 1984; Gerein & Ross 1991; Ndao 1992) that could potentially discourage busy mothers from attending (Nabarro & Chinnock 1988). Finally, not taking into account various cultural definitions and practices concerning child growth could hamper the communication process, as such reducing the acceptance and the participation rate. Adequate local beliefs and caring practices concerning child growth are seldom incorporated in the educational and promotional messages of GMP programs (Lovel *et al.* 1984; Launer & Habicht 1989; Kolsteren *et al.* 1997). Cultural definitions of adequate growth are usually disregarded in favour of the antropometric criteria of Western medicine (Cape 1988; Fagbule *et al.* 1991). And, weighing children is not always considered a harmless act. In some cultural contexts like Peru, Nepal or Burkina Faso (Mull 1991; Kolsteren *et al.* 1997), the weighing basket is perceived

as a potential source of 'contamination' from which children can contract malnutrition.

7. Intervals for repeating the test should be determined

One month is the currently recommended interval for weighing children under the age of two (WHO 1986). The basis for this is unclear. As in the only study concerning this issue, Briend and Bari found that a weight loss in the previous 3 months had a two times greater mortality risk than a weight loss in the previous month. Thus, a 3-monthly interval would seem more adequate than monthly screening (Briend & Bari 1989). The consideration that sensitivity of the screening would fall when extending the interval might have led to the current recommendation.

Still, two more arguments point to favouring less frequent screening. First, the results of the screening – early detection of growth falterers – should be balanced against the cost for organizing the sessions and importantly, for managing the false positives. The more sensitive the test is, the more false positives that can be expected, thus increasing the cost of the whole program. Second, the variance of weight measurements will decrease proportionally when the interval is extended (as discussed under points 2 and 3).

For these reasons, some propose to let depend the choice of the cut-off point and of the interval of measurements on local considerations such as logistics, objective of the screening, health environment, health services, resources available for intervention, periodicity of food insecurity, etc. (Habicht & Pelletier 1990).

8. There should be adequate health service provision for the extra clinical workload resulting from the screening

It can easily be computed that the monthly weighing of around 4% of the total child population in developing countries (children under 2 years of age) will necessitate important staff-time resources. If resources are scarce this constitutes an important opportunity cost, possibly compromising the follow-up management of the detected cases especially if caseload is high. An evaluation of three child health programs in Zaire calculated that the theoretical gain in health service efficiency by targeting children through GMP was largely nullified by the considerable staff-time required for the weighing procedures. As such, in economical terms counselling all children regardless of their nutritional status would be as recommendable (Gerein & Ross 1991).

An increased workload also endangers the quality of the services (Pyle 1986; Vasundhara & Harish 1993). In an observational study, workload was related with the

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respondents' knowledge (Owen & Owen 1983). In order to reduce the workload for the professionals, GMP programs oftentimes rely on low-skilled community volunteers (Hendratta & Rohde 1988). However, the way they interact with mothers is crucial to the quality of the service (Gopalan 1988; Mapatano *et al.* 1997). And in order to maintain it, they need to be trained in nutritional counselling (Gopalan 1988; Msefula 1993), provided with clear decisional algorithms and supervised for their technical and communication performance (Gorstein *et al.* 1994; Valadez *et al.* 1996). All of which requires important investments in staff-time and running costs.

9. The risks associated with the screening should be less than the benefits

As outlined (see point 3), educational benefits are likely to be low and information on the impact on nutritional status is scanty. Associated physical risks, although never reported, are likely to be low. Several authors however warn against the potential negative psychological impact on children and parents because of false positive classifications and because of inadequate advice given by poorly qualified and sometimes overloaded health workers (Jelliffe & Jelliffe 1987; Behague 1993; Msefula 1993; Mapatano *et al.* 1997; Garner *et al.* 2000). However this point has not been documented clearly.

10. The costs should be balanced against the benefits

The widespread assumption is that GMP, because it is based on simple technologies and low-skilled community health workers, does not cost a lot (WHO 1986). Evidence suggests that this is probably not the case. And although costs vary in different settings, even within the same country (Griffiths *et al.* 1996), cost estimations based on a number of programs are rather high (Pelletier & Shrimpton 1994). In Kenya, the provision of direct recording scales, training of mothers, supervision of community health workers, and checking of cards was estimated to cost US \$1.60 per year per child. But the price increased to US \$2.90 when costs of fuel, vehicle maintenance, and staff wages were included (Meegan *et al.* 1994). In Jamaica, the cost per child per year for GMP rose to US\$6.2 (Melville *et al.* 1995). The NCBC project in Indonesia had an annual cost of US \$2.05 per beneficiary [reported by Griffiths (1988)]. A cost factor that is not being considered in all these estimations is the indirect cost for the parents' participation.

No report was found that tried to estimate the cost-effectiveness of GMP programs, which is not surprising because – as indicated (see point 3) – evidence on effectiveness is lacking.

11. The screening should be applied regularly and largely to the whole population

Because effectiveness is also determined by coverage, we added an eleventh criterion to those of Wilson and Jungner. GMP programs are oftentimes not applied regularly nor largely to the whole population (Gerein & Ross 1991). In most reports that were retrieved, GMP was included in a full package of preventive services. And these studies showed that GMP attendance became irregular when the vaccination schedule was completed (Grant & Stone 1986; Achadi & Berman 1988; Ndao 1992; Suelan & Briones 1992; Msefula 1993; Rasheed *et al.* 1996; Mapatano *et al.* 1997). Only one study of a community-based program in South Africa reported a high regularity of mothers to the weighing sessions even in the absence of provision of other health services (Faber *et al.* 1998). A study in India reported that almost half of 3704 rural children aged 0–6 years had never had their growth monitored in their life (Gopaldas *et al.* 1990). In Zaire, the most at-risk children as defined by their mothers' educational and socio-economic level attended the sessions the least often (Gerein & Ross 1991). Others report that the most severely malnourished children were the least likely to be brought to child health services (Gopalan & Chatterjee 1989; Coetzee & Ferrinho 1994). In Congo, it was shown that regularity of attendance at GMP sessions was associated with the distance between the health facility and the home (Ndao 1992). It is clear that if this selection bias occurs, it seriously reduces the overall efficiency of a GMP program. The main findings are summarized in Table 1.

Discussion

We reviewed the literature to assess how GMP performs against the criteria of Wilson and Jungner for screening programs, adding a criterion of coverage. The most remarkable finding is that for only two criteria sufficiently strong evidence was found (criteria 1 and 11). For all other criteria, studies are not available or their quality is poor, so that assessment is based on collateral evidence. The results are rather discouraging despite the very sensitive search we did.

These results are surprising for a program that runs for more than 40 years in almost all developing countries. In a recent review on growth monitoring practices (de Onis *et al.* 2004) a questionnaire was sent to Ministries of Health of 202 countries. The survey yielded 178 responses, which shows the wide implementation of this routine practice in Africa ($n = 50$), Asia ($n = 41$), Europe ($n = 34$) and Latin America and Caribbean ($n = 30$). Numerous problems were however reported, such as

D. Roberfroid *et al.* Performance of growth monitoring and promotion programs**Table 1** Summary of the review findings by Wilson and Jungner criteria

Criteria	Summary of findings
1. The condition should be an important health problem	Malnutrition is an important public health problem but its importance varies among settings. Therefore the impact of GMP programs is likely to vary considerably when implemented in different contexts.
2-3. It should have a detectable early stage and its natural history should be understood	Theoretically weight loss can be considered the early stage of malnutrition. But there is not enough information about the risks associated with different patterns of weight losses to define a cut-off point, which should prompt caretakers and health workers into action. The predictive value of a slowdown in weight gain will be influenced by the magnitude of the deceleration, the incidence of malnutrition and possibly by other contextual factors.
4. Treatment at an early stage provides more benefit than at a later stage	On theoretical grounds it can be stated that early management of weight decelerations is more beneficial than waiting until the condition worsens. But no studies were retrieved considering this issue. The question on whether early treatment leads to improved caring practices or children's nutritional status has been addressed in the literature. The available evidence – although low in quality – suggests that the impact of GMP is rather low. Comparative studies on effectiveness of GMP <i>vs.</i> any other strategy for improving nutritional status were not found. But, one study evidenced that the growth chart might not have any additional benefit over intensive home-based nutrition counselling.
5. There should be a suitable test for the early stage	No validation studies have been reported on the value of the growth chart as a screening tool. But, there is evidence weakening its potential performance. The reference currently used is not appropriate for breastfed children. Sensitivity and specificity of the test cannot be determined due to a lack of a clear cut-off point for the early stage. And for a given cut-off point, the unreliability of weight measurements under field conditions affects its value as a screening test to an unknown extent.
6. The test should be acceptable to the caretakers	The evidence regarding the acceptability of GMP by caretakers is scarce but suggests that acceptability is likely to be low or at least variable depending on the social and/or cultural context.
7. Intervals for repeating the test should be determined	There is not sufficient evidence available on the most adequate length of the intervals for weighing children. But, correlated evidence suggests that the current recommendation of monthly intervals is too frequent.
8. There should be adequate health service provision for the extra clinical workload resulting from the screening	The high proportion of cases to be screened and the high proportion of positive cases to be counselled make that GMP programs are costly in terms of staff-time required. And could have a high opportunity cost in resource poor settings. Replacing professionals with community volunteers without providing adequate support and supervision does not guarantee a sufficient quality of the services, and can at best only partly resolve the problem of provision of follow-up after the screening.
9. The risks associated with the screening should be less than the benefits	There is no evidence regarding the risks/benefits balance in GMP programs.
10. The costs should be balanced against the benefits	There is some evidence that the cost of GMP can be important. No information has been reported on the cost-effectiveness of these programs.
11. The screening should be applied regularly and largely to the whole population	There is some evidence from various settings that GMP is not always applied largely to the whole child population, but rather to some sub-groups of children who are not necessarily the most at risk of malnutrition and thus in need of this service.

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'interpreting the growth curve' (48%), 'inaccurate plotting' (40%), and 'understanding reference curves' (29%). Lack of trained personnel or equipment was less frequently cited (7%), and only 20% mentioned 'no problems'. The study did not address whether specific actions were undertaken following identification of malnourished children, nor were issues such as impact and coverage documented. Despite its wide use growth monitoring remains technically problematic, which was already stressed in 1994 by Morley who drew attention to the fact that interpretation of growth charts could be difficult even for post-graduate doctors.

Nevertheless, it is difficult to imagine a childcare program that does not include some form of regular anthropometric measurement (WHO 1995). What form this regular measuring should take is difficult to answer but following our analysis, following points need to be considered.

First we need a better evaluation of the influence of context specific variables. Malnutrition is definitely an important health problem in developing countries by virtue of its high prevalence and the vital risk it bears. But its relation with morbidity and mortality is highly context dependent and so is the impact of any screening program (de Onis *et al.* 2004). Vital risk is indeed influenced by many factors, such as age range, accessibility and quality of health facilities, prevalence of infectious diseases, socio-economic status of the parents, and season. Consequently, the description of the natural history will also have to be context-specific. In certain high risk situations like emergencies screening can be very useful given the high prevalence and limited causality.

Second, criteria for decision making need to be clarified to efficiently select children at risk of malnutrition or at risk of dying within specific contexts. The current recommendation is that any weight deceleration should alarm health workers and parents for initiation of action. Only one study tried to estimate the predictive value of such a test, and results were disappointing. Evidence indicates that specificity is low. Reliability of this test is further compromised because of the poor levels of precision reached by health workers under field conditions and because of the normal physiologic variations of a child's weight. The result is a very unreliable test that is likely to classify many children wrongly as at risk. WHO and UNICEF, recognizing the technical limitations, have modified their approach when setting up the new Integrated Management for Childhood Illness (IMCI) initiative. They recommend the use of the position on the weight-for-age charts rather than assessing adequacy of growth velocity. Evaluations have been reported for various settings with sensitivity and specificity assessment of the nutrition detection component among others (Bern *et al.* 1997; Simoes *et al.* 1997), and further evaluation is

ongoing in an attempt to measure the impact of the whole management procedure on child mortality. On the other hand, with the introduction of a new reference growth curve, WHO intends to reinforce the use of length or height monitoring and complementary judgement criteria for community-based growth monitoring programs, to allow a more appropriate targeting of interventions (de Onis *et al.* 2004). They recognize however that it will require more time, equipment and training for health workers. This indicates how urgent it is to better evaluate the real benefit, which can be expected from these various changes before any extensive promotion of the new guidelines. Research on alternative indices for assessing growth patterns (Argyle 2003; Carey *et al.* 2004) should also be encouraged and properly evaluated for their field use as screening tests.

A third important point is the frequency of the measurements, which also has a bearing on the predictive value of the test. Although evidence is extremely scant, it seems that the current frequency of monthly measurements reduces specificity. The danger is that many false positives receive warnings and advice that does not apply to them. This can provoke misunderstanding, discouragement, mistrust and jeopardize acceptance. Health workers could become discouraged to invest in counselling. Frequency also affects workload for health workers. A few attempts have been made to evaluate alternatives. Recently Ross and English (Ross & English 2005) introduced a more pragmatic approach in a Kenyan district by weighing babies with a birth weight of 2500 g or more only at follow-up visits coinciding with the immunization schedule. This decreased weighing episodes and workload by 72%. However their evaluation covers only the first 3 months of life and is not a randomized controlled study. Further well-designed evaluations are needed to document the benefits of this possibly promising initiative.

Lastly, as indicated by the low participation rates, acceptance is likely to be low. Growth monitoring is not only a costly exercise for mothers in terms of transport and waiting time, but also an activity for which there is not much demand. Low demand is a general problem affecting many peripheral health centres (Bryce *et al.* 2004), believed to be due to lack of perception of the benefits, related to the limited time allocated for communicating with the parents. Hampshire *et al.* (2004), reviewing the delivery of nutrition services in health systems in three sub-Saharan African countries, show that routine growth monitoring was rarely used to guide subsequent nutritional counselling to the individual child. Not only is the information transmission limited, also the form it takes is very standardized. It is now widely accepted that determinants of health behaviour are complex in nature (Andrien & Beghin 1993; Conner & Norman 1995; Baranowski *et al.* 2003) and that therefore,

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an individual and comprehensive diagnosis should be made assessing the particular situation of the child with a positive screening test in order to tailor advice and treatment.

Conclusion

Reviewing GMP from the perspective of a screening program does not provide much support for its indiscriminate international promotion. The overall aim to reduce the burden of disease by preventing malnutrition does, however, have a strong scientific base. The question then is which strategy should be adopted to prevent this. Our review was not intended to answer this question, but indicates that solutions have to be found for both components of GMP i.e., the education and weighing. Appreciation of the nutritional status of a child is an integral part of a more elaborate global analysis of the health status of the child. Finding out the reasons for malnutrition together with the parents and considering their livelihood should be the start of a counselling process. The counselling should also consider the complexity of health behaviour, and actively involve the parents and where possible the community at large. It also interesting to note that parents do have a way of evaluating their children's growth and development, and would like to share their experience with health workers. Counselling is a form of highly professional care needing skill, experience and time. In many GMP programs these are not available because use is made of low-skilled staff or volunteers. Health professionals do not often engage in counselling because they did not receive adequate training in counselling, are not supervised on it or because workload does not permit it. A more appropriate index to use is weight for height, allowing a direct diagnosis and alleviating the need for serial measurements and decreasing false positives due to stunting. Specificity can also be increased by targeting specific risk groups and introducing weight for height measurement in curative services. Some would call this 'good clinical practice' but it is rarely done because weighing is organized and considered a preventive activity. Acceptability for the parents can be increased by reducing their costs with reduction of the number of visits planned. This can be achieved by focusing on critical periods (breastfeeding initiation, introduction of complementary foods, accident prone periods, vitamin supplements, vaccination,...), combining messages and adapting a counselling approach at contact times. Finally, the crucial element appears the skill of the health worker.

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