The MyFampal Parent App

Methodological Summary of Reporting Results Using Dials

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Contents

Background

The MyFampal Parent™ service ('MyFampal Parent') is an HTML5 application designed to help parents and caregivers monitor emotional, behavioral and physical well-being in their family and compare results with population data. Table 1 summarizes the 14 measurement tools that measure aspects of well-being contained within MyFampal Parent™. With the exception of Cantril Ladder Outlook, all tools are designed to be reported by the parent / caregiver.

TABLE 1: MEASUREMENT TOOLS USED IN MYFAMPAL PARENT

Focus	Measurement Tool	Dial Report?	References
Family	Family Assessment Device (FAD)	Y	[1]
Caregiver	World Health Organization Quality of Life Instrument (WHOQOL-BREF)	Y	[2,3]
Caregiver	Adverse Childhood Experience Inventory (ACE)	N	[4,5]
Caregiver	Positive Childhood Experience Inventory (PCE)	N	Copyright MyFampal
Caregiver	Impact of Childhood Experiences on Adult Life (ICEAL)	N	Copyright MyFampal
Child	Pediatric Symptom Checklist 35 (PSC-35)	Y	[6]
Child	Quality of Life Instrument (KINDL)	Y	[7]
Child	Cantril Ladder Outlook (CAN)[a]	Y	[8]
Child	Physical Well-being Body Mass Index (PW-BMI)	Y	[9]
Child	Physical Well-being Exercise (PW-E)	Y	[10]
Child	Physical Well-being Sleep (PW-S)	Y	[11]
Child	Risky Behavior Checklist (RBC)	N	Copyright MyFampal
Child	Adverse Childhood Experience Inventory (ACE)	N	[4,5]
Child and Caregiver	Mood-click™ (MC-6)	N	Copyright MyFampal

The principal reporting format for each measurement tool is a dial. A dial is chosen because it is reported to be effective in representing analogue data that can have a large number of different states.[12] We also designed the dials for clarity according to human factors research from the auto industry.[13]

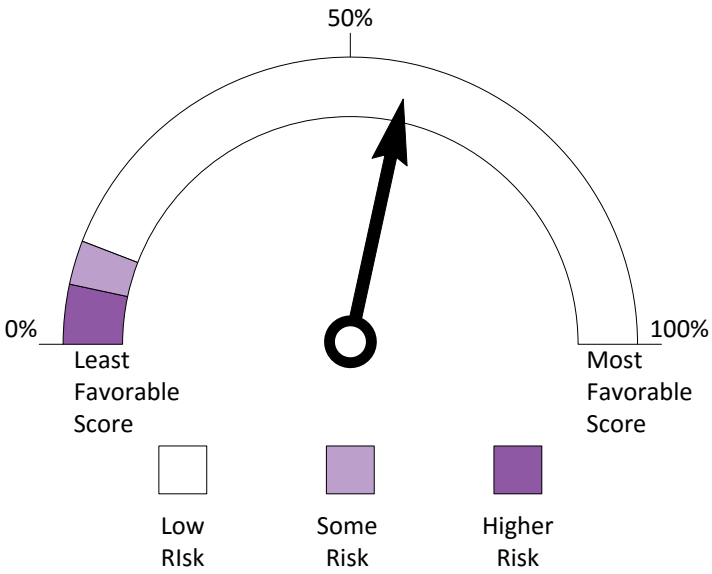
The dial reads like a car fuel gauge and comprises three common features (Figure 1):

(1) the range of the dial spans the whole population from 0% (least favorable score or outcome) to 100% (most favorable score or outcome at which point the whole population is accounted for) except where noted in Table 2.
(2) the dial is divided into three zones, whose relative size is calculated uniquely from the properties of each measurement tool. We label the White Zone 'Low Risk', the light purple zone 'Some Risk' and the dark purple zone 'Higher Risk'.

[a] 2-item questionnaire reported by child using primary caregiver's browser-enabled device

(3) the pointer on the dial compares an individual result from each measurement tool with the distribution of results for that tool within a population.

FIGURE 1: COMMON FEATURES OF EACH DIAL SHOWING POPULATION, ZONES AND POINTER



The example shown in Figure 1 indicates that ~56% of a population score the same or less favorably than the result reported, and ~44% score more favorably.

Six measurement tools do not use this reporting format and are not covered in this report.[b]

Objective

To describe the methods and data used to produce the zones and pointers on each dial for the eight measurement tools where it is used.

[b] ACEx2, PCE, ICEAL, PW-R, MC-6

Statistical Methods and Zone Thresholds

We report methods and zone thresholds used in MyFampal Parent in Table 2 starting on page 6. The next section provides a worked example from one subscale of the WHOQOL-BREF instrument.

WHOQOL-BREF Example

1. Calculate the score for the questionnaire using applicable manual
2. Use calculated score to estimate the position of the score within a US population using published data and appropriate statistical method

1. WHOQOL-BREF Physical Health Subscale Score Calculation

Pain and discomfort *	5
Energy and fatigue *	4
Sleep and rest	5
Dependence on medication	4
Mobility	5
Activities of daily living	5
Working capacity	4
Score (x)	**18.29**

* transformed

2. Statistical Analysis

Derived using cumulative normal distribution function gives the probability that a variate will assume a value <=x, is the integral of the normal distribution (NORM.DIST in MS Excel 2016[c]). Variate x, with mean μ, and standard deviation σ.

$$D(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{x} e^{-(x'-\mu)^2/(2\sigma^2)}\, dx'$$

Variate (X)	18.29
Mean (μ)	15.5[14]
Standard Deviation (σ)	3.2[14]

Resulting position within population = 80.8%.

[c] For more help on this function consult the Excel user guide online

This means that approximately 19% of the US population report a Physical Health Score on WHOQOL-BREF of equal to or more favorable than this, and approximately 81% of the population report a score less favorable.

TABLE 2: SUMMARY OF METHODS AND ZONE THRESHOLDS FOR MYFAMPAL PARENT

Family Assessment Device (FAD)

Each subscale results in a score between 1.00 (most favorable) and 4.00 (least favorable)

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
Problem Solving (6)	1.00	2.07	2.20	4.00	Statistical Methods: Cumulative normal distribution based on mean and s.d. of scores published in validation study population.[15] Truncated at floor and ceiling. Excel 2016 Function: NORM.DIST. Floor: Least possible result. Some Risk: 1/3 s.d. less than published Cut-off Threshold.[15] Higher Risk: Published Cut-off Threshold.[15] Ceiling: Greatest possible result.
Communication (9)	1.00	2.07	2.20	4.00	
Roles (11)	1.00	2.19	2.30	4.00	
Affective Responsiveness (6)	1.00	2.02	2.20	4.00	
Affective Involvement (7)	1.00	1.93	2.10	4.00	
Behavior Control (9)	1.00	1.75	1.90	4.00	
General Functioning (12)	1.00	1.86	2.00	4.00	

World Health Organization Quality of Life Instrument (WHOQOL-BREF)

General Quality of Life & General Health result in an integer score between 5 (most favorable) and 1 (least favorable). Other subscales result in a score between 20.00 (most favorable) and 4.00 (least favorable).

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
General Quality of Life (1)	5	1	1	1	Statistical Methods: None (General Quality of Life & General Health), or 1-cumulative normal distribution based on mean and s.d. of scores published in validation study population, truncated at floor and ceiling (other subscales). Excel 2016 Function: 1-NORM.DIST. Floor: Greatest possible result. Some Risk: Score=2 (General Quality of Life & General Health) or closest possible score to a 10 centile reduction compared with the Higher Risk threshold (other subscales).[14] Higher Risk: Score=1 (General Quality of Life & General Health) or closest possible score to 95th centile of population (other subscales).[14] Ceiling: Least possible result.
General Health (1)	5	1	1	1	
Physical Health (7)	20.00	11.43	9.71	4.00	
Psychological (6)	20.00	9.33	8.00	4.00	
Social Relationships (3)	20.00	8.00	6.67	4.00	
Environment (8)	20.00	8.00	7.00	4.00	

Pediatric Symptom Checklist 35 (PSC-35)

Summary Score results in an integer score between 0 (most favorable) and 62/70 (least favorable) for Pre-School/School-Aged children respectively. Attention Problems & Internalizing Problems subscales result in an integer score between 0 (most favorable) and 10 (least favorable); Externalizing Problems subscale ranges between 0 and 14.

Subscale (# Qs) [d]	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
Pre-School Summary Females (31)	0	21	24	62	Statistical Methods: For Summary Scores, a cumulative lognormal distribution based on mean and s.d. of scores published in study population, truncated at floor and ceiling.[e 16] For subscales, an exponential cumulative distribution function with λ set such that population at the cut-off score equals the population at the age and sex matched cut-off Summary Score. Excel 2016 Functions: LOGNORM.DIST; EXPON.DIST. Floor: Least possible result. Some Risk: For Summary Scores, 1/3 s.d. less than cut-off score rounded to closest possible score. For subscales, an exponential cumulative distribution function. Higher Risk: Published cut-off score for Summary Scores.[16] An exponential cumulative distribution function for subscales. Ceiling: Greatest possible result.
Pre-School Summary Males (31)	0	22	24	62	
School-Aged Summary Females (35)	0	24	28	70	
School-Aged Summary Males (35)	0	25	28	70	
Attention Problems	0	5	7	10	
Internalizing Problems	0	3	5	10	
Externalizing Problems	0	5	7	14	

Quality of Life Instrument (KINDL)

The KINDL Total Score and all subscales are calculated and transformed to a score between 100 (most favorable) and 0 (least favorable).

Subscale (# Qs) [d]	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
3-6 years Total Score (47)	100	66.79	63.40	0	Statistical Methods: For Total Scores and subscales, the inverse of the standard normal cumulative distribution function, truncated at floor and ceiling.[7,17] Excel 2016 Function: -NORM.S.INV. Floor: Greatest possible result. Some Risk: For all scales and subscales, 1/3 s.d. less than Higher Risk score rounded to closest calculable score. Higher Risk: Closest score that accounts for >95th centile population for the specific age and sex matched subscale. Ceiling: Least possible result.
7-10 years Total Score	100	67.34	64.33	0	
11-13 years Total Score (35)	100	58.27	53.96	0	
14-17 years Total Score (35)	100	58.80	55.01	0	
3-6 years Physical	100	59.63	54.39	0	
3-6 years Emotional	100	68.07	64.27	0	
3-6 years Self-esteem	100	56.09	51.65	0	

[d] Where there is no #Qs reported, this is because all subscales are calculated from data collected from Summary or Total Scores

[e] Lognormal distribution chosen because scores are not normally distributed

3-6 years Family	100	65.09	61.12	0	
3-6 years Friends	100	63.56	59.46	0	
3-6 years Every-day Functioning	100	67.46	63.30	0	
3-6 years Dis-ease (6) [f]	100	40.56	35.48	0	
Girls 7-13 years Physical	100	55.82	51.09	0	
Girls 7-13 years Emotional	100	68.25	64.47	0	
Girls 7-13 years Self-esteem	100	43.29	37.35	0	
Girls 7-13 years Family	100	67.55	63.26	0	
Girls 7-13 years Friends	100	60.03	55.43	0	
Girls 7-13 years Everyday Func-tioning	100	57.98	53.88	0	
Girls 7-13 years Disease (6) [f]	100	40.56	35.48	0	
Boys 7-13 years Physical	100	59.59	55.25	0	
Boys 7-13 years Emotional	100	68.90	65.34	0	
Boys 7-13 years Self-esteem	100	41.67	35.35	0	
Boys 7-13 years Family	100	66.35	61.97	0	
Boys 7-13 years Friends	100	61.45	57.19	0	
Boys 7-13 years Everyday Func-tioning	100	55.46	51.16	0	
Boys 7-13 years Disease [f]	100	46.14	41.55	0	
Girls 14-17 years Physical	100	45.45	39.65	0	
Girls 14-17 years Emotional	100	62.50	58.21	0	

[f] KINDL Disease subscale only collected if caregiver reports 'Yes' to a disease/hospitalization filter question

Girls 14-17 years Self-esteem	100	33.14	26.79	0	
Girls 14-17 years Family	100	52.32	46.43	0	
Girls 14-17 years Friends	100	60.39	55.90	0	
Girls 14-17 years Everyday Functioning	100	47.86	43.46	0	
Girls 14-17 years Disease [f]	100	40.69	35.76	0	
Boys 14-17 years Physical	100	60.04	55.68	0	
Boys 14-17 years Emotional	100	64.01	60.08	0	
Boys 14-17 years Self-esteem	100	37.90	31.46	0	
Boys 14-17 years Family	100	57.20	51.52	0	
Boys 14-17 years Friends	100	62.74	58.76	0	
Boys 14-17 years Everyday Functioning	100	45.17	40.49	0	
Boys 14-17 years Disease [f]	100	47.99	43.69	0	

Cantril Ladder Outlook (CAN)

Score Now and Score Future are each reported between 10 (most favorable) and 0 (least favorable). We devised MyFampal Parent Combined Score enabling a result between 20 (most favorable) and 0 (least favorable).

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
Cantril (MyFampal Parent Combined Score) (2)	20	14.5	8	0	Statistical Methods: Linear regression equations calculated between published population distributions for 'Thriving', 'Struggling' and 'Suffering' populations reported by Gallup. We recalculated a Combined Score as the sum of Score Now and Score Future. If the Gallup Cantril analysis resulted in a 'Suffering' result, the Combined Score was rescaled from 5 to 17 in integer increments, to 8.5 to 14.5 in 0.5 point increments. Excel 2016 Function: NA. Floor: Greatest possible result. Some Risk: Lower threshold of 'Thriving' Zone (Combined Score=8).[18] Higher Risk: Upper threshold of 'Suffering' Zone (Combined Score=15). [18] Ceiling: Least possible result. Note that data is available for multiple countries and is used where applicable. Where published data did not sum to 100%, the greatest of the three values published was adjusted.

Physical Well-being Body Mass Index (PW-BMI)

BMI (Kg/m^2) is calculated in the standard way. Unlike all other scales used, the resulting BMI score can be unfavorable at each extreme of the scale. We derive MyFampal Parent BMI scale extremes from published data (BMI of 12.1 and 40.0).[9]

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
BMI Low (2)	0%	5%	10%	100%	Statistical Methods: Standard normal cumulative distribution function derived from published LMS values for U.S. male and female children aged 2 to 17 years. The LMS values are the median (M), the generalized coefficient of variation (S), and the power in the Box-Cox transformation (L) for each age and sex permutation.[9] Excel 2016 Function: NORM.S.DIST. Floor: 12.1 BMI, which is rounded to 0% population for all age and sex permutations (results less than this are truncated). Some Risk: 10% (low BMI)[9] or 80% (high BMI). Higher Risk: 5% (low BMI)[9] or 85% (high BMI).[9] Ceiling: 40.0 BMI, which is rounded to 100% population for all age and sex permutations (results greater than this are truncated).
BMI High	0%	80%	85%	100%	

Physical Well-being Exercise (PW-E)

Physical Exercise (minutes per day) is estimated from the mean of data collected across seven consecutive days and compared with expert consensus recommendations. Guidelines for very young children (aged 2-4 years) and older children (aged 5+ years) is 180 minutes and 60 minutes per day respectively.[10]

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
Minutes Physical Exercise 2-4 years (7)	210	179	59	0	Statistical Methods: None. Until data allows, we present zones as equal 60° regions based on guideline definitions 'Meets recommendations', 'Some activity' and 'Low activity' populations, and position the needle centrally within each zone.[10] Excel 2016 Function: NA. Floor: Set at 210 minutes (children aged 2-4 years) and 90 minutes (older children). Some Risk: One minute less than recommended daily activity level. Higher Risk: One minute less than 'Some activity' threshold. Ceiling: Zero minutes per day.
Minutes Physical Exercise 5-7 years (7)	90	59	29	0	
Minutes Physical Exercise 8-10 years (7)	90	59	29	0	
Minutes Physical Exercise 11-12 years (7)	90	59	29	0	
Minutes Physical Exercise 13-15 years (7)	90	59	29	0	

Physical Well-being Sleep (PW-S)

Total Sleep (hours per 24-hour period) is estimated from the mean of data collected across seven consecutive days and compared with a population distribution.[11] Note that Total Sleep is comprised of night time sleep duration and daytime naps.

Subscale (# Qs)	Floor	SmRsk.	HgrRsk.	Ceiling	Positioning Pointer and Zone Thresholds within a Population
Hours Total Sleep per 24-hour period 3 years (7)	15.3	11.2	10.7	8.2	Statistical Methods: 1-cumulative normal distribution based on mean and s.d. published in a sleep study in children, truncated at floor and ceiling (other subscales).[11] Excel 2016 Function: 1-NORM.DIST. Floor: Sleep duration rounded to nearest 0.1 hour (6 minutes). Some Risk: Higher Risk threshold - 0.5 s.d. for age of child.[11] Higher Risk: Sleep duration reported by less than 95th centile of the population for age of child.[11] Ceiling: Sleep duration rounded to nearest 0.1 hour (6 minutes) truncated at >99% population threshold. Note, data is shown only for children aged between 3 and 16 years.
Hours Total Sleep per 24-hour period 16 years (7)	9.9	7.3	6.9	5.4	

HgrRisk.=Higher Risk Zone lower threshold; SmRsk. = Some Risk Zone lower threshold. # Qs=Number of Questions; s.d.=standard deviation.

Caveats and Assumptions

General caveats that are not specific to each measurement tool are shown in the next three bullet points. Specific caveats for each measurement tool are shown in Table 3.

- **Dial Thresholds:** Dials are designed to represent an individual response within a population distribution. Thresholds are designed to simplify presentation of a continuum of risk, not to present a dichotomous result.
- **Generalizability:** Many of the tools included in MyFampal Parent have not been evaluated in all countries and languages. Interpreting results in one country using population data collected in another should be treated with caution.
- **Uncertainty:** Uncertainty around the point estimate is not displayed on the dials, although it is known to vary between questionnaires.
- **Sub-Group Analyses:** Some tools report data for subgroups, however (with the exception of BMI for a US population), data is sparse.

TABLE 3: MAIN CAVEATS AND ASSUMPTIONS USED IN DIAL DESIGN IN MYFAMPAL PARENT

Measurement Tool	Caveats and Assumptions	Implication
Family Assessment Device (FAD)	Response scores are normally distributed.	The position of the dial pointer or thresholds may alter slightly if alternative population distributions are identified.
	Cut-off scores from a US population are generalizable to non-US populations.	Non-US populations should treat the dial pointer and thresholds with caution until local country data is available.
	Cut-off scores have not changed since the original research was conducted.	Contemporary publications that have not been identified, or future research, may change the cut-off thresholds.
World Health Organization Quality of Life Instrument (WHOQOL-BREF)	It is valid to categorize unusually low quality of life scores as either 'Higher Risk' or 'Some Risk'.	The dial displays how uncommon the response is. Whether the categorization is a cause for concern will depend on the individual respondent.
	Response scores for all countries follow the same distribution.	All respondents should treat the dial pointer or thresholds with caution until local country data is available.
Pediatric Symptom Checklist 35 (PSC-35)	The PSC results do not follow a normal distribution. It is valid to use a lognormal transformation to estimate cumulative population distributions.	The position of the dial pointer or thresholds may alter slightly if alternative population distributions are identified.
	Subscale scores follow an exponential cumulative distribution function with λ set such that population at the subscale cut-off score equals the population at the age and sex matched cut-off Summary Score.	The position of the dial pointer or thresholds for the three subscales will change if good data on subscale population distributions are identified.
	Cut-off scores from a US population are generalizable to non-US populations.	Non-US populations should treat the dial pointer and thresholds with caution until local country data is available.
Quality of Life Instrument (KINDL)	As for WHOQOL-BREF, we assume it is valid to categorize unusually low scores as either 'Higher Risk' or 'Some Risk'.	The dial displays how uncommon the response is. Whether the categorization is a cause for concern will depend on the individual respondent.

Measurement Tool	Caveats and Assumptions	Implication
	Response scores for all countries follow the same distribution as a German non-immigrant population.	All respondents should treat the dial pointer or thresholds with caution until local country data is available.
Cantril Ladder Outlook (CAN)	Children understand and enter data on their score using their caregiver smartphone understand what they are being asked and are not influenced by their parents.	Cantril Ladder has not been validated for parents reporting their child's responses and any deviation from the child reporting their score without influence should be treated as invalid.
	Cantril Ladder population data were only identified for adults and we assume that children follow the same response pattern.	Treat findings with caution until we have sufficient data to calculate country-specific distributions for children.
	The Gallup 'Suffering' and 'Struggling' categories are valid thresholds for 'Higher Risk' or 'Some Risk' zones used in MyFampal Parent.	The dial displays how uncommon the response is. Whether the categorization is a cause for concern will depend on the individual respondent.
	It is valid to use an adjusted aggregate score for the 'Struggling' category to position a response within a population. The distribution of responses within a population follows a linear distribution between published population proportions.	All respondents should treat the dial pointer or thresholds with caution until local country data is available to generate more accurate distributions.
	100% population as accounted for at MyFampal Parent Combined Score of 0.	Some populations may never report a Combined Score of 0 ('worst Combined Score' state), although this is very unlikely to alter interpretation, since >95% populations in English speaking countries included are accounted for by Combined Score 8.
Physical Well-being Body Mass Index (PW-BMI)	BMI data is routinely collected by many countries and very detailed BMI data was identified for a US population. We assume other English speaking countries follow a similar distribution.	The position of the dial pointer or thresholds may alter if alternative population distributions are identified for each country.
Physical Well-being Exercise (PW-E)	We chose to present dial zones as equal size and three needle positions based centrally within each zone depending on exercise time reported.	The PW-E dial does not present an accurate distribution until better data is available.
	The UK has established recommended Physical Exercise targets for children aged between 2 and 15 years. We assume these are applicable to all countries.	If other countries set differing exercise targets, the dial thresholds should be treated with caution.
	It is valid to assume that calculating Physical Exercise duration as a mean of a single week may be extrapolated to 'typical behavior'.	If respondents alter their exercise patterns during the week where data is collected, this invalidates the assumption.
	No published data was identified for children aged 16-17 years and we assume adolescents of this age follow the same distribution as children aged 13-15 years.	Treat the results for children aged 16-17 years with caution until better data is available.

Measurement Tool	Caveats and Assumptions	Implication
Physical Well-being Sleep (PW-S)	We chose to produce dial zones from Swiss population distribution, not guidelines.	The importance of adequate sleep may be underestimated by glancing at the dial and not reading the accompanying text.
	We extrapolate sleep duration to adolescents aged 17 years, since no data was identified.	Until data for local countries is collected results for adolescents aged 17 years should be treated with caution, however, given the observed progression in younger children we do not believe our estimate is unreasonable.
	The sleep duration study we identified was conducted in Switzerland and published in 2003. We assume that the sleep durations cited in this study are generalizable to contemporary families and all countries.	Pressures on sleep patterns in children have changed greatly since the introduction of smartphones and tables, which are frequently reported as major barriers to sleep, so zone thresholds we use may be an optimistic assumption.

Discussion

This paper reports the features of dial design and underpinning statistical analyses used to provide meaningful interpretation of individual results within MyFampal Parent. We have demonstrated that it is possible to simplify reporting of disparate questionnaires in a common format familiar to anyone who drives a car.

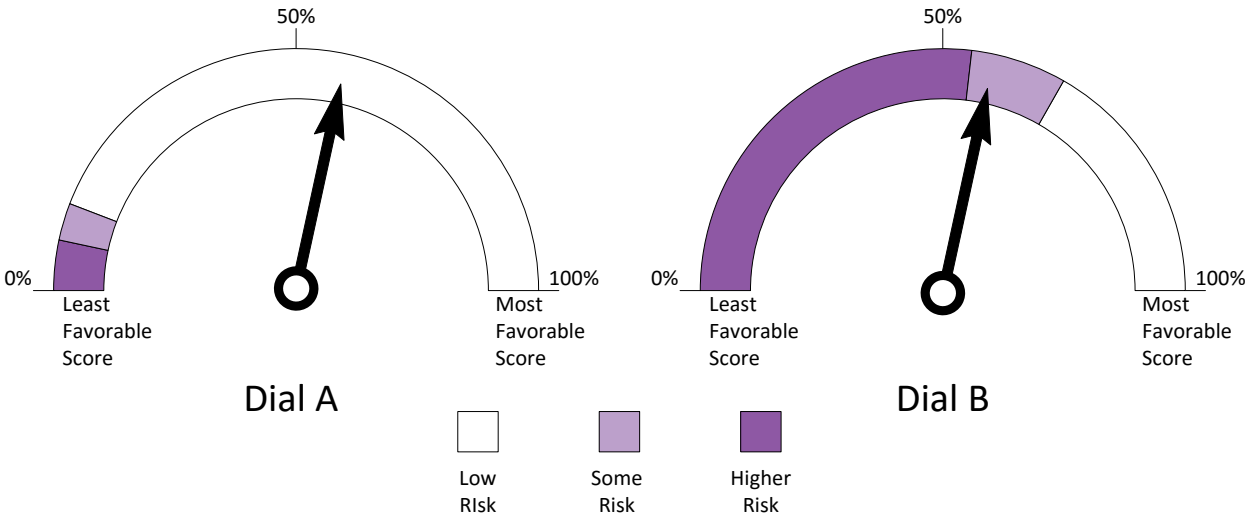
We highlight that many results should be treated with caution since population data are sparse and may not be generalizable. Explanatory text will further improve understanding of results.

Future research that results in increased country and subgroup data, will improve the accuracy of our pointer and zone positions.

Comparison data is available for two aspects of Physical Well-being (sleep and exercise) but was not used in MyFampal Parent at the outset. The data shows that for some subgroups (particularly older teens), the proportion achieving target levels of either sleep or exercise is less than 10%.[10,19] The Adolescent Research Committee advised that a dominant Higher Risk zone may be confusing to parents. We draw attention to target sleep and exercise duration in the text accompanying the respective dials, and plan to revisit this decision once better population data has been collected.

The dials we have designed communicate more than just the location of a single result compared with a population. The relative sizes of the Some Risk and Higher Risk zones communicate how much of a challenge the domain being measured is to the rest of the population. For example, when considering Dial B in Figure 2 (Behavior Control, a domain of FAD, not to scale), we believe the dial communicates that: 'Many families do not achieve a target level of Behavior Control. My Family is also not quite achieving this target, but is not unusual'. We trust that users will be able to interpret what this means, but will need to test this assumption.

FIGURE 2: EXAMPLES OF VARIATION IN DIAL DISPLAYS THAT MAY BE CHALLENGING TO INTERPRET



The dials we have designed share common features as we outlined in the introduction, however, we do not yet know how consistently users will interpret pointer results or variation in the size of 'Some Risk'

and ‘Higher Risk’ zones. For example, when considering the two very different dials A and B in Figure 2, the pointers both indicate that the respondent is located at approximately 55% of the population on both dials. However, for a tool where very few respondents would be anticipated to have an unfavorable result (Dial A), the sizes of the zones are small and the pointer is not close to either unfavorable zone. Conversely, when considering Behavior Control (Dial B FAD example), we estimate that 54% of families achieve a FAD threshold score of 1.90, based on published guidelines, and the pointer is in a Some Risk zone.[15]

All dials are constructed such that the least favorable result is at the 9 o’clock position (far left of the dials used in the examples). This is akin to the ‘low fuel’ zone on a car fuel gauge. During development, we tested reversing the dial with a sample of parents, such that it read like a car rev counter. The feedback we received indicated a strong preference for the fuel gauge choice. It will be useful to assess whether a larger population of users maintains this preference.

There are numerous other graphical methods of displaying results on a screen and we have an opportunity to expand reporting styles to improve understanding, or to account for different user preferences in future research.

References

1 Epstein NB, Baldwin LM, Bishop DS. The McMaster family assessment device*. *J Marital Fam Ther* 1983; **9**: 171–180.

2 WHOQOL-BREF: introduction, administration, scoring and generic version of the assessment: field trial version, December 1996. 1996. http://www.who.int/iris/handle/10665/63529 (accessed Sept 25, 2015).

3 WHOQOL User Manual. World Health Organization, 1998.

4 Finkelhor D, Shattuck A, Turner H, Hamby S. Improving the adverse childhood experiences study scale. *JAMA Pediatr* 2013; **167**: 70–5.

5 Redding CA, Anda RF, Felitti VJ. Finding Your ACE Score. Health Presentations.

6 Jellinek MS, Murphy JM, Robinson J, Feins A, Lamb S, Fenton T. Pediatric Symptom Checklist: Screening school-age children for psychosocial dysfunction. *J Pediatr* 1988; **112**: 201–9.

7 Ravens-Sieberer U, Bullinger M. KINDL(R) Manual Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents Revised Version. 2000. http://www.kindl.org/english/manual/ (accessed March 23, 2016).

8 Cantril H. The pattern of human concerns. New Brunswick, N.J.: Rutgers University Press, 1966.

9 Growth Charts - Percentile Data Files with LMS Values. 2009; published online Aug 4. http://www.cdc.gov/growthcharts/percentile_data_files.htm (accessed April 6, 2016).

10 Scholes S, Mindell JA. Physical activity in children. In: National Statistics Health Survey for England - 2012, HSA 2012. The Health and Social Care Information Centre, 2013: 41.

11 Iglowstein I, Jenni OG, Molinari L, Largo RH. Sleep Duration From Infancy to Adolescence: Reference Values and Generational Trends. *Pediatrics* 2003; **111**: 302–7.

12 Stone D, Jarrett C, Woodroffe M, Minocha S. User Interface Design and Evaluation. Morgan Kaufmann, 2005.

13 Green P. Human Factors and Gauge Design: A Literature Review. University of Michigan: Transportation Research Institute, 1988.

14 Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial. A Report from the WHOQOL Group. *Qual Life Res* 2004; **13**: 299–310.

15 Ryan CE, Epstein NB, Keitner GI, Miller IW, Bishop DS, editors. Evaluating and treating families: the McMaster approach. New York: Routledge, 2005 https://books.google.com/books?id=4-P-fdnmUpoC&dq=evaluating+and+treating+families&lr=&source=gbs_navlinks_s.

16 Jellinek MS, Murphy J, Little M, Pagano ME, Comer DM, Kelleher KJ. Use of the pediatric symptom checklist to screen for psychosocial problems in pediatric primary care: A national feasibility study. *Arch Pediatr Adolesc Med* 1999; **153**: 254–60.

17 Ravens-Sieberer PDU, Ellert U, Erhart M. Gesundheitsbezogene Lebensqualität von Kindern und Jugendlichen in Deutschland. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 2007; **50**: 810–8.

18 Ray J. Nearly One in Four Worldwide Thriving. Gallup.com. 2012; published online April 12. http://www.gallup.com/poll/153818/Nearly-One-Four-Worldwide-Thriving.aspx (accessed Dec 4, 2015).

19 How much sleep do kids need? - Live Well - NHS Choices. 2015; published online April 9. http://www.nhs.uk/Livewell/Childrenssleep/Pages/howmuchsleep.aspx (accessed April 6, 2016).