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Research Article

Determinants of Attrition to Follow-Up in a Multicentre Cohort Study in Children-Results from the IDEFICS Study

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Cohort participant retention is a crucial element and may depend on several factors. Based on data from a multicentre cohort of European children, the effect of baseline participation on attrition and the association with and the impact of single determinants in relation to the extent of attrition were investigated. Data was available for 16,225 children from the IDEFICS baseline survey (2007/2008). Attrition was defined as nonparticipation in the first follow-up examination (2009/2010). Determinants of attrition were analysed by logistic regression. The statistical significance level was set at $\alpha = 0.01$ to account for the large sample size. The strongest associations were seen for baseline item non-response, especially when information on migration background (odds ratio (OR) = 1.55; 99% confidence interval (CI): 1.04, 2.31), single parenthood (OR = 1.37; 99% CI: 1.12, 1.67), or well-being (OR = 1.46; 99% CI: 1.19, 1.79) was lacking. Drop-out proportion rose with the number of missing items. Overweight, low education, single parenthood and low well-being scores were independent determinants of attrition. Baseline participation, and the individual determinant effects seemed unrelated to the variation of the extent of attrition between study centres. A high level of item nonresponse as well as overweight and disadvantageous sociodemographic conditions were identified as main attrition determinants, suggesting the consideration of these aspects in conduct and analysis of cohort studies in childhood obesity research.

1. Introduction

In longitudinal studies, participant adherence is a crucial element of study organisation that requires considerable effort and time. However, attrition is an inevitable problem in almost every epidemiological cohort study, which leads to a loss of power and potentially introduces selection bias when drop-out is related to the exposures or outcomes of

interest. The most commonly reported types of attrition are noncontact or refusal [1]. In fact, the motivation of study participants to remain involved in the study activities may decline over time and will depend on several factors. To apply appropriate analysis strategies and to allow for a correct interpretation of the results from longitudinal studies, knowledge on the determinants of attrition is important. Additionally, information about factors affecting attrition is crucial to improve retention of cohort participants. One aspect that has been reported to affect attrition is baseline response and concomitant recruitment efforts [2]. With regard to longitudinal studies in children and adolescents, where parental consent is commonly required, low parental education level, migration background, and single parenthood have been suggested to mainly determine attrition rates [3, 4]. However, there is little experience regarding the effects of different determinants of attrition in a multicentre study where the same standardized study protocols are applied. Such data would facilitate the comparison between study centres that have different attrition proportions and baseline responses and the extent of potential selection effects.

This report presents results regarding the proportionate attrition from baseline (T0) to the first follow-up examination (T1) of the multi-centre IDEFICS (identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study. We investigated systematic drop-out related to weight status as well as to known obesity risk factors, such as low educational level and migration background. Also, behavioural factors that have been identified as determinants of overweight, such as screen time [5], sleep duration [6], or dietary behaviour [7, 8], and certain psychosocial aspects [9] were examined as possible attrition determinants. Selective drop-out with regard to these factors might affect the interpretability of results in longitudinal studies of obesity research. Additionally, allocation to either the intervention or the control region (see the following for more details) might play a role in this context and was therefore another determinant of interest in the present study.

In this paper we (1) assess determinants of attrition and evaluate whether (2) the baseline participation in the study centres is associated with attrition and (3) whether the impact of attrition determinants is stronger in centres with a high proportionate attrition.

2. Methods

2.1. Study Population. The IDEFICS project is a population-based multicentre intervention study which included children aged 2 to 9 years from eight European countries.

Between September 2007 and May 2008, 31 543 children from schools and preschools in selected regions in Italy, Estonia, Cyprus, Belgium, Sweden, Hungary, Germany, and Spain were asked to participate in the baseline survey (T0) based on a two-stage random sampling strategy with schools presenting the first and classes presenting the second level of sampling units. Of those children 16864 (53.4%) accepted the invitation, with 16225 (51.4%) providing the parental questionnaire and measurement of weight and height [10]. They thus fulfilled the preset inclusion criteria and were eligible for the present analysis. The baseline survey was followed by a community- and setting-based intervention program concerning diet, physical activity, and stress coping, which was implemented in intervention regions in each of the participating countries, while no intervention was offered in the control regions [11]. Two years later, every child who had participated in the T0 survey was automatically reinvited to take part in the T1 survey (September 2009 to June 2010). Both, T0 and T1 involved a similarly extensive study protocol including anthropometric examinations, collection of biosamples (urine, saliva, blood), fitness, and sensory tests as well as questionnaires on diet, psychosocial, behavioural, and environmental factors to be filled in by the parents. More detailed information on the study protocol and procedures can be found elsewhere [12].

Two age groups were defined with one group including children aged 2 to <6 years (preschool children) and the other group including children aged 6 to 9 years (school children) at baseline.

In each country, the participating centres obtained ethical approval by their responsible authority. All children and their parents provided oral and written informed consent, respectively, for all examinations and/or the collection of samples, subsequent analysis, and storage of personal data and collected samples. More detailed information on the study design, applied instruments, and measurements as well as baseline response rates with regard to the respective study modules has been presented elsewhere [10].

2.2. Measurements

2.2.1. Attrition. The outcome measure was a dichotomous variable for attrition at two-year follow-up (T1 participant versus T1 nonparticipant). The amount of attrition per study centre was expressed as a percentage of the number of baseline participants.

2.2.2. Baseline Characteristics. All measurements were conducted according to a manual of standardized procedures in all centres. Body height was measured without shoes by trained staff using a portable stadiometer (SECA 225). Weight was measured by means of an adapted version of electronic scale TANITA BC 420 SMA, wearing only underwear. BMI was calculated and then categorized according to the criteria of the International Obesity Task Force [13]. Our reference category included normal and underweight children. Data on personal, social, environmental, and behavioural factors of each child, such as parental education level, family status, migration background, time spent in front of a TV or PC screen (screen time), and well-being was collected by means of a standardized parental self-completion questionnaire. Education level was categorized according to the International Standard Classification of Education (ISCED). Four levels of education (low versus medium-low versus medium-high versus high) were created out of the six ISCED levels, with ISCED levels 0–2 being defined as low education, level 3 being defined medium-low, level 4 being defined as medium-high, and level 5 and higher being defined as high education. Migration background was defined as either mother

or father of the child or both parents being born in a foreign country. Family status was defined as single versus two-parent families.

A well-being scale was developed, including information on emotional well-being, self-esteem, family, and friends. Though the scale itself was not validated, these questions were based on the respective subscales from the Kiddy-KINDL^R for parents of children aged 4–7 years, a validated questionnaire for measuring health-related quality of life in children [14]. Answers were given according to a 4-point Likert scale (never, rarely, sometimes, often/all the time), that was adapted to the original 5-point Likert scale of the KINDL^R. Since the IDEFICS parental questionnaire did not comprise the whole subscale set from KINDL^R (questions on physical well-being and everyday functioning were excluded in IDEFICS) no total instrument score, but only sum scores based on the included subscales were created as proposed by the authors of the original instrument [15]. Based on these scores we created four well-being categories (low, medium-low, medium-high, and high). More detailed information on the KINDL^R scores can be found at http://www.kindl.org/ [15].

Information on dietary habits was obtained from a validated standardized Food Frequency Questionnaire (CEHQ-FFQ) [16, 17]. A variable representing the weekly consumption of junk food (including sweetened drinks, chocolate or nut based spreads, snacks) was created based on this data. Furthermore, the parents were asked if soft drinks were available during meals (yes versus no).

Sleep duration was assessed using a 24-hour dietary recall (SACINA). SACINA is a computer-based instrument that was filled out by parents or guardian of each participating child and contained questions on the time at which the child got up in the morning and went to bed on the previous day. Nocturnal sleep duration was calculated as the difference between bed and get-up time in the SACINA interview resulting in a continuous variable. More detailed information on the sleep duration assessment in IDEFICS is given elsewhere [6, 18]. Two sleep duration categories were created (≤11 hours of sleep versus >11 hours of sleep).

A "non-response-score" was developed, taking into account the amount of item non-response per participant with regard to the variables of the baseline survey, resulting in four categories: none (no item non-response); low (1 item non-response); medium (2 or more item non-responses).

Baseline participation rate was included in the analysis as a dichotomous variable per study centre with the categories low (<50%) versus high (≥50%).

2.3. Statistical Analysis. Descriptive analyses describe attrition proportion and sample characteristics in the participating study centres (countries). Chi square statistics were used for comparison of categorical variables. To analyse the association between potential determinants and individual attrition (as a dichotomous dependant variable) we used separate logistic regression models. More precisely, we applied the procedure GLIMMIX (SAS Institute, Cary, North Carolina, USA) and included adjustments for the second-level random effect (country) as well as the simultaneous consideration of age and sex (Model 1). In a further step, we defined a multivariate logistic regression model (Model 2), which combined all variables showing a statistically significant effect, or an estimated odds ratio (OR) ≥ 1.50, in the separate Model 1, to identify the strength and independence of the impact of single determinants on attrition. For sensitivity analysis, forward selection of covariates was additionally applied for model development to investigate if this approach would lead to inclusion of the same variables in the model. In order to compare whether the impact of determinants is related to the variation in the extent of attrition between study centres we conducted a country-stratified analysis (separate models for each country based on model 1), where country was used as a proxy for the degree of attrition. The statistical significance level was set at $\alpha = 0.01$ to account for the large sample size.

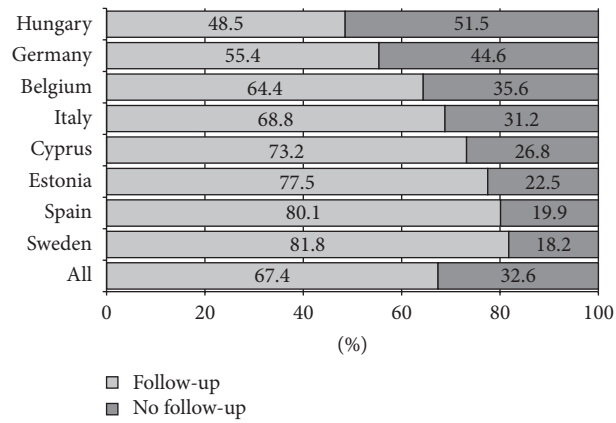

Figure 1: Attrition and participation proportion by country.

3. Results

Among the 16225 children who participated in the IDEFICS baseline survey, the proportion of boys and girls was nearly equal in all survey centres, while slightly more school than preschool children participated in the survey in most countries, except for Sweden and Belgium. Striking country differences were seen in the percentage of obese and overweight children (e.g., Italy: 19.5% and 22.5%; Belgium: 2.3% and 6.4%, resp.) as well as in other potential determinants of attrition. Thus, for example, the proportion of children with migration background and parents with low educational level was very low in Estonia (4.6% and 1.9%, resp.) as compared to Germany (34.1% and 35.5%, resp.). The proportion of single parents was low in Sweden (8.5%) and relatively high in Italy (28.9%). A detailed overview of all potential attrition determinants under investigation is given in Table 1.

The average proportionate attrition in the IDEFICS follow-up was 32.6%, but it varied significantly between countries ($P < 0.001$), ranging from 18.2% in Sweden to 51.5% in Hungary (Figure 1).

Table 2 presents proportionate attrition and effect estimates for each category of the investigated factors applying two levels of adjustment (Models 1 and 2). Each potential

Table 1: Baseline Response and Baseline Characteristics of Children in the IDEFICS Study by Country.

	Estonia		Sweden		Germany		Belgium		Hungary		Italy		Spain		Cyprus		All	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Region																		
Intervention	793	46.1%	902	49.9%	1179	57.1%	976	50.7%	1277	49.7%	1182	52.5%	798	53.0%	1373	57.7%	8480	52.3%
Control	926	53.9%	907	50.1%	886	42.9%	950	49.3%	1292	50.3%	1068	47.5%	709	47.0%	1007	42.3%	7745	47.7%
Sex																		
Male	850	49.4%	934	51.6%	1051	50.9%	978	50.8%	1286	50.1%	1165	51.8%	773	51.3%	1226	51.5%	8236	50.8%
Female	869	50.6%	875	48.4%	1014	49.1%	948	49.2%	1283	49.9%	1085	48.2%	734	48.7%	1154	48.5%	7962	49.1%
Age																		
Pre-school	859	50.0%	918	50.7%	876	42.4%	1043	54.2%	1039	40.4%	974	43.3%	715	47.4%	954	40.1%	7378	45.5%
School	860	50.0%	891	49.3%	1189	57.6%	883	45.8%	1530	59.6%	1276	56.7%	792	52.6%	1426	59.9%	8847	54.5%
Weight status																		
Obese	69	4.0%	36	2.0%	92	4.5%	44	2.3%	149	5.8%	438	19.5%	88	5.8%	211	8.9%	1127	6.9%
Overweight	178	10.4%	160	8.8%	237	11.5%	123	6.4%	288	11.2%	507	22.5%	223	14.8%	345	14.5%	2061	12.7%
Normal weight	1472	85.6%	1613	89.2%	1736	84.1%	1759	91.3%	2132	83.0%	1305	58.0%	1196	79.4%	1824	76.6%	13037	80.4%
Migration background																		
No	1572	91.4%	1433	79.2%	1304	63.1%	1726	89.6%	2398	93.3%	1846	82.0%	1310	86.9%	1404	59.0%	12993	80.1%
Partly	69	4.0%	180	10.0%	210	10.2%	72	3.7%	83	3.2%	329	14.6%	75	5.0%	377	15.8%	1395	8.6%
Full	11	0.6%	146	8.1%	493	23.9%	42	2.2%	19	0.7%	54	2.4%	86	5.7%	240	10.1%	1091	6.7%
Missing	67	3.9%	50	2.8%	58	2.8%	86	4.5%	69	2.7%	21	0.9%	36	2.4%	359	15.1%	746	4.6%
Educational level																		
Low	33	1.9%	32	1.8%	734	35.5%	78	4.0%	78	3.0%	484	21.5%	142	9.4%	78	3.3%	1659	10.2%
Medium-low	674	39.2%	331	18.3%	513	24.8%	513	26.6%	1107	43.1%	1338	59.5%	409	27.1%	285	12.0%	5170	31.9%
Medium-high	725	42.2%	180	10.0%	410	19.9%	430	22.3%	255	9.9%	0	0.0%	160	10.6%	518	21.8%	2678	16.5%
High	230	13.4%	1215	67.2%	321	15.5%	850	44.1%	1069	41.6%	410	18.2%	767	50.9%	1144	48.1%	6006	37.0%
Missing	57	3.3%	51	2.8%	87	4.2%	55	2.9%	60	2.3%	18	0.8%	29	1.9%	355	14.9%	712	4.4%
Family status																		
Two parents	1414	82.3%	1606	88.8%	1675	81.1%	1677	87.1%	2036	79.3%	1477	65.6%	1322	87.7%	1086	45.6%	12293	75.8%
Single parent	214	12.4%	153	8.5%	309	15.0%	184	9.6%	394	15.3%	651	28.9%	132	8.8%	391	16.4%	2482	15.3%
Missing	91	5.3%	50	2.8%	81	3.9%	65	3.4%	139	5.4%	122	5.4%	53	3.5%	903	37.9%	1504	9.3%
Well being																		
Low	217	12.6%	156	8.6%	333	16.1%	272	14.1%	847	33.0%	543	24.1%	210	13.9%	449	18.9%	3027	18.7%
Medium-low	414	24.1%	352	19.5%	436	21.1%	371	19.3%	906	35.3%	617	27.4%	442	29.3%	427	17.9%	3965	24.4%
Medium-high	524	30.5%	646	35.7%	666	32.3%	668	34.7%	598	23.3%	649	28.8%	541	35.9%	356	15.0%	4648	28.6%
High	406	23.6%	540	29.9%	314	15.2%	431	22.4%	48	1.9%	273	12.1%	183	12.1%	97	4.1%	2292	14.1%
Missing	158	9.2%	115	6.4%	316	15.3%	184	9.6%	170	6.6%	168	7.5%	131	8.7%	1051	44.2%	2293	14.1%
Weekly screen time																		
≤7 hours	312	18.2%	444	24.5%	756	36.6%	632	32.8%	820	31.9%	622	27.6%	586	38.9%	502	21.1%	4674	28.8%
7 to ≤14 hours	603	35.1%	839	46.4%	699	33.8%	732	38.0%	937	36.5%	817	36.3%	554	36.8%	805	33.8%	5986	36.9%
>14 hours	717	41.7%	446	24.7%	448	21.7%	466	24.2%	706	27.5%	721	32.0%	288	19.1%	625	26.3%	4417	27.2%
Missing	87	5.1%	80	4.4%	162	7.8%	96	5.0%	106	4.1%	90	4.0%	79	5.2%	448	18.8%	1148	7.1%
Junk food																		
Never	121	7.0%	276	15.3%	30	1.5%	26	1.3%	227	8.8%	184	8.2%	126	8.4%	84	3.5%	1074	6.6%
Occasionally	778	45.3%	1160	64.1%	431	20.9%	534	27.7%	1132	44.1%	831	36.9%	810	53.7%	673	28.3%	6349	39.1%
Often	588	34.2%	272	15.0%	1369	66.3%	1118	58.0%	937	36.5%	979	43.5%	465	30.9%	477	20.0%	6205	38.2%
Missing	232	13.5%	101	5.6%	235	11.4%	248	12.9%	273	10.6%	256	11.4%	106	7.0%	1146	48.2%	2597	16.0%
Soft drink available																		
Yes	423	24.6%	32	1.8%	1060	51.3%	486	25.2%	579	22.5%	321	14.3%	64	4.2%	158	6.6%	3123	19.2%
No	1224	71.2%	1690	93.4%	896	43.4%	1300	67.5%	1892	73.6%	1906	84.7%	1395	92.6%	930	39.1%	11233	69.2%
Missing	72	4.2%	87	4.8%	109	5.3%	140	7.3%	98	3.8%	23	1.0%	48	3.2%	1292	54.3%	1869	11.5%

Table 1: Continued.

	Estonia		Sweden		Germany		Belgium		Hungary		Italy		Spain		Cyprus		All	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Sleep duration																		
≤11 hours	1289	75.0%	848	46.9%	937	45.4%	209	10.9%	865	33.7%	1578	70.1%	464	30.8%	908	38.2%	7098	43.7%
>11 hours	42	2.4%	366	20.2%	649	31.4%	199	10.3%	36	1.4%	64	2.8%	40	2.7%	45	1.9%	1441	8.9%
Missing	388	22.6%	595	32.9%	479	23.2%	1518	78.8%	1668	64.9%	608	27.0%	1003	66.6%	1427	60.0%	7686	47.4%
Item nonresponse																		
None	1490	86.7%	1644	90.9%	1649	79.9%	1628	84.5%	2276	88.6%	1907	84.8%	1299	86.2%	1150	48.3%	13043	80.4%
Low	159	9.2%	104	5.7%	296	14.3%	204	10.6%	214	8.3%	295	13.1%	163	10.8%	249	10.5%	1684	10.4%
High	70	4.1%	61	3.4%	120	5.8%	94	4.9%	79	3.1%	48	2.1%	45	3.0%	981	41.2%	1498	9.2%
Baseline response	54.5%		65.6%		48.2%		58.3%		43.7%		60.0%		41.4%		49.9%		51.4%	

determinant variable includes a category which represents the missing values (non-response) for the respective item. Attrition proportions in the single categories of possible determinants ranged from 27.7% (children from highly educated parents) to 46.8% (children whose parents did not report their educational level). After control for country, age, and sex, the strongest impact on attrition was observed when baseline variable values were missing and children with non-response to certain items in T0 were about two times as likely to drop out of follow-up as children with information on these aspects. Thus, a high combined non-response score showed the highest impact of all potential determinants under investigation with a clear dose-effect relationship (low score: OR = 1.45; 99% confidence interval (CI): 1.26, 1.68; high score: OR = 2.63; 99% CI: 2.10; 3.29).

Other, in particular sociodemographic and psychosocial factors were attributed to attrition as well. Hence, children from families where both parents were born in a foreign country were more likely to drop out as were children with parents of low educational background, while children from highly educated families showed a particularly high probability to participate in T1 (Table 2). Effects on attrition could be revealed also for some psychosocial aspects such as a low well-being score or a long screen time. Similarly, overweight and obese children participated less often in the follow-up examinations than normal weight children. In Model 2, age group, overweight/obesity, parental education level, migration background, family status, well-being, screen time, and the baseline proportionate participation were included. The non-response score variable was omitted from Model 2 to avoid overadjustment, since a missing category was already included for each of the variables in the model. The strongest effect on attrition was found for non-response regarding the items migration background, family status, and well-being. Generally, most of the effects (except for screen time) observed in model 1 persisted as statistically significant after multivariate adjustment although the associations were somewhat attenuated. Of note, sex, allocation in intervention or control region, dietary behaviour (junk food consumption and availability of soft drinks), sleep duration, and participation rate at baseline were not related to attrition in these models. Also considering baseline response as a continuous variable in sensitivity analysis, no correlation was found with proportionate attrition (Pearson's $r = -0.37$; $P = 0.36$). Sensitivity analysis for model development applying forward selection of covariates resulted in the inclusion of the same variables as in the model based on the originally used selection procedure. The hierarchy for inclusion of the selected covariates was as follows: country, migration background, family status, well-being of the child, socioeconomic status, age group, and overweight.

Country-stratified comparisons regarding the main determinants for drop-out are given in Figure 2. No specific patterns or clustering of the determinants of attrition in the different countries were identified, indicating that the impact of determinants is not substantially stronger in centres with a high attrition proportion.

4. Discussion

Our results confirmed the hypothesis that overweight/obesity and factors related to obesity risk affect attrition to follow-up in a cohort study of children. This association was independent from differences in baseline proportionate participation and attrition to follow-up. The strongest effects in the adjusted models were seen for overweight/obesity and for item non-response at baseline, the latter especially with regard to migration background, family status, and well-being. A dose-effect relationship was found within the study centres between the numbers of item non-responses and the drop-out. Generally, the extent of attrition does not seem to be related to the size of specific determinants for drop-out. The suggestion that selective drop-out due to a differential loss of individuals with specific patterns of obesity-related factors is stronger in study centres with high attrition proportions was thus not confirmed by our study. Sensitivity analysis excluding data from Spain and Belgium in Model 1 was conducted to account for the extremely high values in these countries with respect to the item non-response score. However, the results were only slightly attenuated but not essentially different (e.g., high non-response score: OR = 2.15; 99% CI: 1.69, 2.73).

Determinants of attrition in longitudinal population-based studies have been discussed in several publications [3, 19–21]. In studies of young populations, where parental consent is usually required, sociodemographic factors, such as parental education or single parenthood, have been

Table 2: Proportionate attrition and effect estimates for determinants of attrition in the IDEFICS study.

	Proportionate attrition	Model 1[a]		Model 2[b]	
		OR	99% CI	OR	99% CI
Sex					
Male	32.8%	Reference			
Female	32.3%	0.97	0.89, 1.06		
Age group					
Preschool	33.5%	**1.15**	**1.07, 1.23**	**1.22**	**1.11, 1.34**
School	31.8%	Reference		Reference	
Region					
Intervention	33.0%	Reference			
Control	32.1%	0.96	0.88, 1.05		
Weight status					
Obese	31.7%	**1.36**	**1.14, 1.62**	**1.28**	**1.07, 1.54**
Overweight	35.9%	**1.30**	**1.14, 1.49**	**1.27**	**1.10, 1.45**
Normal weight	36.8%	Reference		Reference	
Migration background					
No	31.0%	Reference		Reference	
Partly	33.0%	**1.26**	**1.07, 1.48**	**1.23**	**1.04, 1.45**
Full	40.6%	**1.57**	**1.31, 1.89**	1.15	0.91, 1.45
Missing	46.6%	**2.44**	**1.98, 3.00**	**1.55**	**1.04, 2.32**
Educational level					
Low	41.4%	**1.31**	**1.11, 1.53**	**1.19**	**1.01, 1.40**
Medium-low	34.0%	Reference		Reference	
Medium-high	31.4%	1.04	0.90, 1.20	1.06	0.92, 1.22
High	27.7%	**0.84**	**0.75, 0.94**	0.88	0.78, 1.00
Missing	46.8%	**2.15**	**1.72, 2.69**	1.09	0.72, 1.68
Family status					
Two parents	30.9%	Reference		Reference	
Single parent	36.3%	**1.28**	**1.13, 1.45**	**1.21**	**1.06, 1.38**
Missing	40.0%	**1.96**	**1.66, 2.32**	**1.37**	**1.12, 1.67**
Well-being					
Low	37.5%	**1.34**	**1.14, 1.59**	**1.26**	**1.07, 1.49**
Medium-low	33.0%	1.18	1.00, 1.38	1.15	0.97, 1.35
Medium-high	29.0%	1.05	0.89, 1.22	1.04	0.89, 1.22
High	25.4%	Reference		Reference	
Missing	39.7%	**1.97**	**1.65, 2.36**	**1.46**	**1.19, 1.79**
Weekly screen time					
≤7 hours	31.6%	Reference		Reference	
7 to ≤14 hours	31.9%	**1.14**	**1.01, 1.27**	1.11	0.99, 1.24
>14 hours	31.9%	**1.16**	**1.03, 1.32**	1.06	0.94, 1.21
Missing	42.3%	**1.96**	**1.63, 2.35**	1.10	0.86, 1.39
Junk food					
Never	29.0%	Reference			
Occasionally	29.7%	1.00	0.83, 1.23		
Often	34.0%	1.00	0.82, 1.22		
Missing	37.8%	**1.53**	**1.23, 1.91**		
Soft drink available					
Yes	38.7%	1.11	0.98, 1.25		
No	30.0%	Reference			
Missing	37.3%	**1.97**	**1.66, 2.33**		

Table 2: Continued.

	Proportionate attrition	Model 1[a]		Model 2[b]	
		OR	99% CI	OR	99% CI
Sleep duration					
≤11 hours	29.0%	0.86	0.72, 1.03		
>11 hours	25.5%	Reference			
Missing	35.3%	1.08	0.91, 1.29		
Item non-response					
No missing	30.8%	Reference			
Low	39.0%	**1.45**	**1.26, 1.68**		
High	40.4%	**2.18**	**1.83, 2.58**		
Baseline participation					
Low	27.3%	1.50	0.54, 4.16	1.33	0.46, 3.89
High	37.3%	Reference		Reference	

CI: confidence interval; OR: odds ratio.
[a] Adjusted for country, sex, and age group.
[b] Adjusted for country, age group, weight status, parental education level, migration background, family status, well-being, screen time, and baseline proportionate participation.

reported as the most relevant attrition determinants [4, 22]. These reports are in line with our results, where socio-demographic aspects including parental education, single parenthood, and migration background also affected nonparticipation in the follow-up study. This suggests that during the conduct of follow-up studies, special attention has to be paid to these groups in order to optimize their study adherence.

Behavioural factors, such as sedentary behaviour or diet, were not or only weakly associated with attrition, which corroborates findings from the Danish Youth Cohort study [3]. However, our data revealed an impact of the children's well-being on attrition. To the authors' knowledge no such association has been previously reported in other studies of young populations. The same applies to the impact of item non-response, in particular to the dose-effect relationship between the number of item non-responses and attrition that was observed in the analysis. This seems to suggest that parents who were reluctant to completely answer the questionnaire or to participate in the respective study modules already at baseline were more likely to not participate after two years. In this context, results from a German cohort should be noted where late invitation response and the intensity of recruitment efforts were determinants of attrition to follow-up [2]. The authors suppose that late response is just an indicator for reluctance to participation and thus probably associated with a high value of the item non-response scores. Unfortunately, local variations in the organization of recruitment procedures in the different study centres and the different settings in each country precluded more detailed analyses of recruitment efforts. Nevertheless, intensified motivation procedures may need to be considered for participants in the cohort panel who show high item non-response scores.

In previous studies it has been discussed that individuals might select themselves out of studies due to treatment or intervention [23]. Interestingly, no differences in attrition were seen with regard to being allocated to the intervention or the control region in the present study, which may indicate that the IDEFICS intervention programme was either well accepted or so low threshold that the decision to take part in the follow-up was unaffected.

An important aspect in this context is the potential for biased estimates in longitudinal analyses due to selective attrition. Selective attrition threatens to impair the generalizability of findings and to bias the estimates of associations [24]. Although evidence for this is limited and conflicting [2, 19], this aspect needs to be considered in the interpretation of our results, in particular regarding how the systematic drop-out in the present study threatens to induce bias in the longitudinal analysis of certain outcomes. Particularly the elevated probability of drop-out for overweight or obese children, or with factors related to the development of overweight, is of particular concern here. Thus, in a prospective analysis using the incidence of obesity as a dichotomous outcome, the differential drop-out of children in the overweight (and even more so in the upper overweight) category, where the progression to obesity is more likely to occur than in children with a lower BMI, introduces an elevated probability of missing the outcome of interest in the follow-up examinations; this might lead to a biased estimation of the association under investigation. Therefore, alternative analytic approaches, for example, by using the relative change in BMI, and thereby identifying changes in the BMI within the whole range of the BMI distribution, as the outcome of interest, could be one approach to diminish the observed limitations in this cohort.

Another example, where the selective drop-out might impair longitudinal analysis, is the study of the incidence of secondary diseases that are more likely to occur in overweight or obese children, for example, type 2 diabetes [25]. The elevated drop-out of children from this group could lead to a relevant loss of statistical power as the number of incident cases may become too low to observe significant effects since these conditions are generally rare (although increasing) within the age group of interest [26]. We suppose that the prospective analysis of observational studies within the context

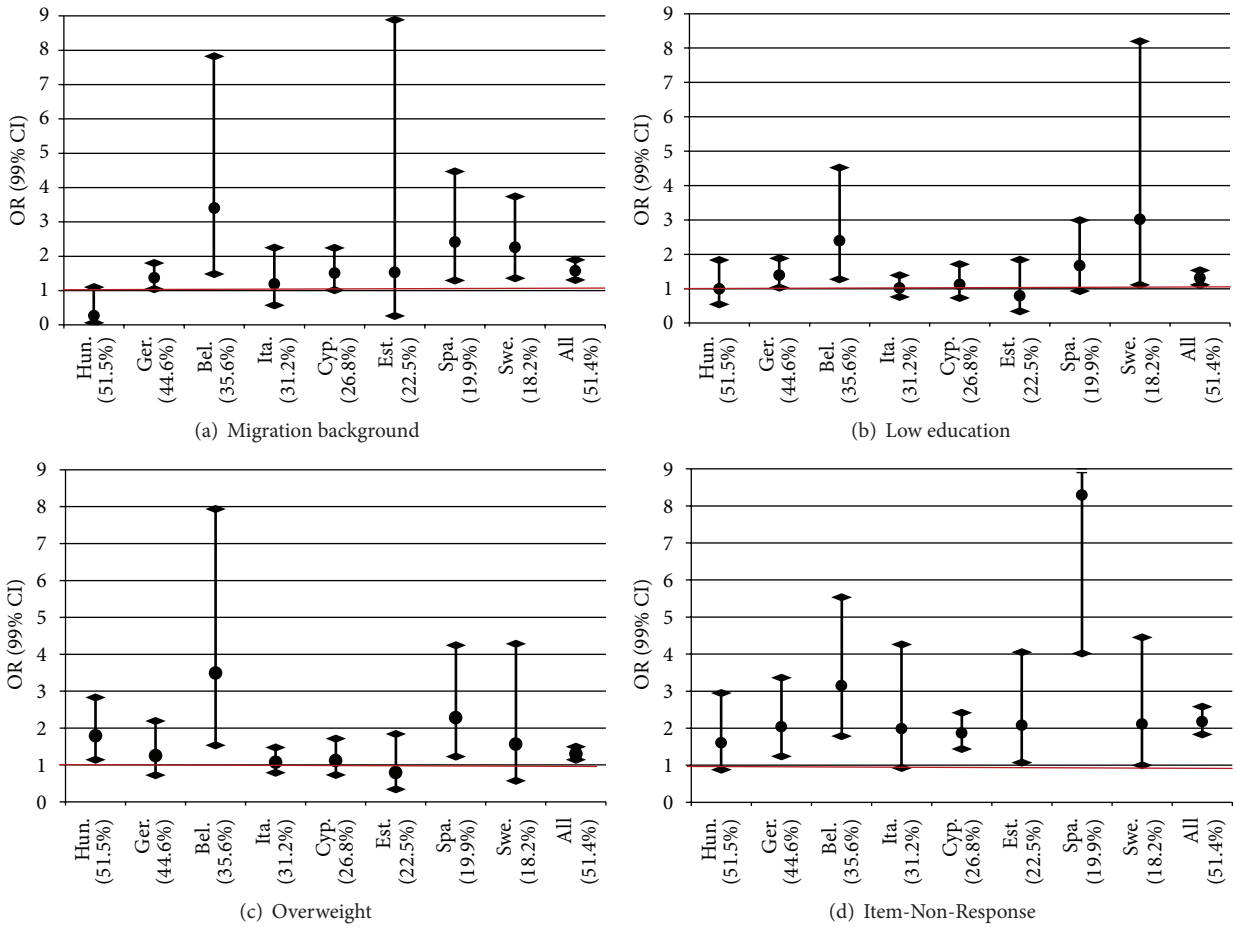

Figure 2: Effect estimates (OR, 99% CI) for the main determinants by country (ordered by the extent of proportionate attrition).

of obesity research in children should conscientiously take these aspects into consideration. While the results concerning obesity-related determinants of attrition cannot be generalized to cohort studies with a different research focus, the identification of item non-response as the factor with the strongest impact might be relevant for most longitudinal studies conducted. This special population group can be identified based on baseline data and extensive recruitment strategies might be developed and applied in order to increase study retention among this population.

Data of the reasons for attrition (lack of interest, illness, lack of time, etc.) would have deepened the analyses in this report. However, no or only partial information on reasons for loss to follow-up was assessed during the field work and therefore no such analysis was feasible in the context of the present study.

5. Conclusion

Our results indicate selective attrition in cohort studies of children which are independent from baseline participation in the study centres. The main determinants of loss to follow-up were a high level of item non-response at baseline, especially lack of information on sociodemographic and psychosocial factors, followed by children's overweight and disadvantageous sociodemographic and psychosocial conditions. Exposure or nonexposure to the intervention programme did not affect participation in follow-up examinations. Observational studies of obesity research in children should provide for these aspects in the longitudinal analysis of data, but preferably already during the planning and conduct of follow-up surveys.

Conflict of Interests

The authors declare that they have no conflict of interests.

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