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**Improving Reports of Health Risks: Life History Calendars and Measurement of  
Potentially Traumatic Experiences**

Running Title: Life History Calendars and PTEs

For Submission to International Journal of Methods in Psychiatric Research, April 2020

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**Acknowledgements:** The authors gratefully acknowledge and thank the professional staff of three collaborating partners who together made this work possible: The survey staff of the Institute for Social and Environmental Research – Nepal for their outstanding fieldwork collecting the data reported here; the staff of the Survey Research Operations unit of the University of Michigan’s Survey Research Center for development and support of the technical systems that made the fieldwork in Nepal possible; and Professor Ron Kessler and the World Mental Health Consortium staff at Harvard University for their input into the design and all

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as doi: [10.1002/mpr.1853](https://doi.org/10.1002/mpr.1853).

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subsequent steps of collecting and analyzing the data reported here. This work was supported by the National Institutes of Health (grant numbers R01MH110872 and P2CHD041028).

### **Abstract**

**Objectives:** Recall error biases reporting of earlier life experiences, even potentially traumatic experiences (PTEs). Better tools for accurate retrospective reporting of PTEs and other health risk factors have the potential for broad scientific and health intervention benefits.

**Methods:** We designed a Life History Calendar (LHC) to support this task, and randomized more than 1,000 individuals to each arm of a retrospective diagnostic interview, including detailed measures of PTEs, with and without the LHC. This is one of the largest experiments ever done to assess the benefit of an LHC approach and the only large-scale experiment done in a poor, agrarian, non-Western setting (rural Nepal).

**Results:** Results demonstrate use of an LHC in retrospective measurement can significantly increase lifetime reports of PTEs, especially reports of two or more PTEs. The LHC increases PTE reporting more for men and those with less education.

**Conclusions:** The LHC approach is practical for many uses ranging from large surveys of the general population to clinical intake of new patients. It significantly increases reporting of health risk factors.

**Keywords:** Life History Calendars, potentially traumatic experiences, recall bias, rural Asia, improving reporting

## Introduction

There is no doubt individuals' prior experiences shape health, including both resilience and health risks (Anda et al., 1999; Chapman et al., 2004; Cronholm et al., 2015). Therefore, all investigations of trajectories of health and wellbeing, from large-scale epidemiology research to clinical intake, include measurements of earlier life experiences or conditions. This widespread use of such measures motivates a priority on creation of tools that enhance accurate reports of prior experiences.

Retrospective reporting of lifetime experiences is cognitively challenging. Life History Calendar (LHC) methods are designed to make the task of recall of the timing of life events easier by engaging respondents in more careful reflection on the timing and sequencing of those life events (Belli, 1998; Caspi et al., 1996; Freedman, Thornton, Camburn, Alwin, & Young-DeMarco, 1988; Petersen & Kerwin, 1992). The tool was pioneered with a focus on memorable life events such education, marriage, childbearing, and divorce (Freedman et al., 1988). Though applied in surveys thirty years ago, this method remains underutilized in public health research, especially global public health research. Using a large-scale, general population, randomized experiment, this study shows that the LHC method can be used to reduce recall error in reports of important experiences.

We focus on the potential for LHC methods to improve recall of potentially traumatic experiences (PTEs). This test of the LHC method reveals both the breadth of LHC potential and also an approach to obtain more complete measurement of crucial health trajectory risks.

Reporting of PTEs is an important example because these are generally considered memorable personal events with potential to shape both physical and mental health. Traumatic experience is not only a fundamental criteria for the diagnosis of post-traumatic stress disorder (PTSD), it is

also a strong predictor of subsequent episodes of other mental disorders, such as major depressive disorder (Chapman et al., 2004; Keyes et al., 2013). In this domain, evidence indicates exposure to multiple traumatic experiences may have a stronger association with subsequent mental disorders than single traumatic experiences (Breslau, Davis, Andreski, & Peterson, 1991; Husarewycz, El-Gabalawy, Logsetty, & Sareen, 2014; Myers et al., 2015), so underreporting of PTEs may lead to misspecified attribution of causes of disorders. Likewise, evidence demonstrates that specific PTEs have the potential to increase a wide range of health risks (Hossain, Zimmerman, Abas, Light, & Watts, 2010; Kelly, Skelton, Patel, & Bradley, 2011). Again, underreporting may lead to both misspecification of population-scale health risks and misdiagnosis of individual-level causes of impairments. Finally, growing evidence demonstrates that early life traumatic experiences have the potential to disrupt trajectories of the transition to adulthood – education, work, or marriage and childbearing – with potential for long-lasting consequences for health and wellbeing (Anda et al., 1999; Bethell, Newacheck, Hawes, & Halfon, 2014). Across an important range of public health issues, tools to improve the recall and reporting of PTEs have the potential to support significant scientific advances.

### **Method**

We designed an LHC for this specific task. In a subsample of a long-running panel study we randomized more than 1,000 individuals to each arm of a retrospective study specially designed for comprehensive measurement of PTEs, but with and without the LHC. We compare rates of reporting lifetime experience of PTEs among those randomized to each arm of the study. We then go on to examine sex, age, and education differences in the effect of LHC administration.

Particularly important for international public health research, we conducted this study in a well-documented general population sample in rural Nepal. In many ways this population is representative of the vast majority of the world's population. This low-income, primarily agrarian population is characterized by few resources including low education and little public infrastructure. The population is also characterized by high exposure to PTEs and other health risks. Finally, as is often true in high-poverty settings, there is little existing health-related data, including no vital registration or digital health-related records. Thus, adaptation of LHC methods to this type of setting is of broad relevance in international public health research and of high scientific value.

LHC designs simplify the cognitively challenging task of recall by providing a matrix of cues respondents can use to help them remember the timing of life events (Belli, 1998; Freedman et al., 1988; Caspi et al., 1996; Petersen & Kerwin, 1992). These timing cues are both standardized (e.g. as column headings marked with years and ages), and flexible, usually composed of respondents' reports of other personal life events, to increase the power of respondents' autobiographical memory (Axinn et al., 2019). Two decades ago, careful adaptation of these methods produced highly successful LHC tools for use across multiple ethnic groups in rural Nepal (Axinn, Barber, & Ghimire, 1997; Axinn, Pearce, & Ghimire, 1999). That research was particularly important for multicultural use of the LHC method because the multiple ethnic groups in rural Nepal not only speak mutually unintelligible languages, they also represent a wide range of conceptualizations of time and use of calendars in daily life (Axinn & Pearce, 2006; Axinn et al., 1999). These successes give the LHC tool a favorable profile for pairing with multicultural interviews to improve recall of earlier life health risks.

## **Applying LHC Methods to Measurement of PTEs**

LHCs are typically designed in the form of a matrix where the columns represent time units (weeks, months, years) and the rows contain the domains of life being studied (Axinn et al., 1999). For examples of different designs of life history calendars, please refer to (Freedman et al., 1988) and (Axinn & Pearce, 2006). The paper calendar used in this investigation (where the interviewer and respondent sit together and use the visual cues and matrix format of the calendar) is described in detail in (Axinn et al., 2019). The top lines begin with Nepal-specific visual cues including Nepalese calendar years and the timing of important national events, then continue with the timing of highly memorable local neighborhood events that are pre-edited for each specific neighborhood before the calendar is administered. Visual aspects of the LHC method help ensure that interviewers collect complete data. The interviewer's work begins with the respondent's age and important personal experiences. This section of the calendar is administered to all respondents prior to the assessment of exposure to PTEs. It includes a complete residential history, a marital and childbearing history, and a history of educational and job change events. Recording this information can take fifteen minutes, but this information becomes a crucial person-specific set of memory cues and the process of remembering and recording all of them creates cognitive engagement in the detailed recall of prior life experiences.

All respondents then begin the substantive portion of the interview which is a standardized questionnaire, including screening for PTE exposure. The only respondents who return to the LHC are those who are unable to remember their age at first exposure to a specific PTE. Interviewers then help these respondents pinpoint the age at which the event was experienced using the information previously recorded on the LHC.

## Key Measures

To measure PTEs, we used the Nepal-specific version of the World Health Organization's (WHO) Composite International Diagnostic Interview (CIDI) (R. C. Kessler & Üstün, 2004, 2008; Pennell et al., 2008; Wittchen, 1994). Note that prior research already documents a clinical validation of the DSM-IV diagnoses produced by this LHC-CIDI instrument (Axinn et al., 2019). Following standard CIDI administration practice, professional interviewers were rigorously trained in administration of the CIDI using computer-assisted personal interviewing, and then went to respondents' homes, obtained privacy, and administered the CIDI. The CIDI modules included Post-traumatic Stress Disorder (PTSD), which generates a comprehensive list of all PTEs ever experienced. Using this list we calculate ever experiencing each type of PTE (1, 0), the total number of different types of PTEs ever experienced (count), and whether or not the respondent reported two or more PTEs (a critical threshold for mental disorder).

Our analysis examines differences in LHC performance by *sex*, *age*, and *education*. We summarize variability in education with a single dichotomous indicator of achieving a "School Leaving Certificate" (SLC). The SLC is awarded to those scoring highly enough on a nationally standardized exam offered after the successful completion of 10<sup>th</sup> grade and variance in this attainment reflects recent changes across cohorts in access to schools.

## Experimental Design

To evaluate the performance of the LHC, we selected a subsample from the ongoing Chitwan Valley Family Study (CVFS) in Nepal. The CVFS launched in 1995 with a *general population sample* of 151 neighborhoods (clusters of 5-15 households) fully representative of

rural Chitwan in Nepal (<https://cvfs.isr.umich.edu/>). All individuals, including migrants from the selected neighborhoods, were then entered into a unique household registry system using state-of-the-art survey methods to achieve high rates of re-contact and re-interview through the present (Axinn, Ghimire, & Williams, 2012). These methods featured frequent re-contact and mixed mode data collection to retain 95% of the original respondents. Both household and individual interviews on social, economic, and demographic topics have been repeated multiple times.

We chose a sub-sample of 50 of the 151 CVFS neighborhoods, and randomly selected 25 neighborhoods to receive an integrated LHC and CIDI interview and the other 25 neighborhoods to receive a CIDI interview with no LHC. This community-level randomization was used to create a geographically matched set of neighborhoods with and without LHCs in the CIDI interview. The sample yielded 1,404 individuals, aged 15 to 59, who were interviewed with CIDI only and 1,089 individuals who completed a LHC first, then the CIDI. Note that randomization took place at the community level, creating unequal samples of individuals, but that both samples attained response rates of over 94%. A key limitation of prior research is the statistical power to detect interactions – this sample size is much larger than any prior experiments with LHC methods, allowing us to compare LHC performance between important subgroups of the population.

We present the percentage of individuals reporting PTEs, the percentage reporting two or more PTEs, and the number of PTEs reported for both samples. Statistical analyses were performed using SAS version 9.4.

## **Results**

### **Sample Characteristics**



The two groups (the “LHC group” and the “non-LHC group”) did not significantly differ in age or sex, but they did differ in ethnic group distribution (Axinn et al., 2019). They also differed in educational attainment, with a higher proportion of the LHC group attaining a greater degree of education (having the SLC).

### **Comparison of PTE Reports with Versus without an LHC**

Receiving the LHC prior to the questions measuring PTEs produces a significant increase in the percentage of respondents who report ever experiencing a PTE (row 1, Table 1). In fact, using the LHC increases reporting in the general population by 6 percentage points – a large, substantively important increase. The LHC also produces significantly higher reports of the total number of lifetime PTEs experienced (row 3, Table 1). However, the LHC has an especially strong effect on reports of two or more PTEs (row 2, Table 1). Interviews featuring an LHC-driven careful engagement in recall of key life events increase overall reports of two or more PTEs by more than 16 percentage points. Although PTEs may be memorable events, the LHC dramatically improves completeness of these reports in ways directly related to health risks – having two or more PTEs is known to significantly increase the likelihood of mental disorders such as PTSD and major depressive disorder (MDD) (Breslau et al., 1991; Husarewycz et al., 2014; Myers et al., 2015). Prior analysis of this same LHC experiment demonstrates that the use of an LHC significantly increases reporting of lifetime symptoms of PTSD and MDD. The new evidence presented here is consistent with conclusion that one reason LHCs can greatly improve reporting of mental disorders is that LHCs help respondents recall that they have had more than one PTE.

*(Table 1, About here)*

### **Interactions of LHC Use with Sex, Age, and Education**

For sex, Table 2 illustrates that the LHC increases reports of PTEs among men significantly more than among women. Among men, use of the LHC approach to engage respondents in their earlier life experiences and help them focus on timing and sequencing of personal events increases the percent reporting any PTE by a large 16 percentage points (row 1, Table 2). Likewise, use of the LHC also produces a statistically significant and substantial increase in the number of PTEs men report (row 3, Table 2). By contrast, use of the LHC produces virtually no change in women's reports of PTEs or the total number of PTEs. The contrast is stark and statistically significant. Also important is the discovery that an LHC significantly improves reporting of two or more PTEs, described above, for *both* men and women (row 2, Table 2). The effects of the LHC are significantly stronger among men, raising the percent who report two or more PTEs by a substantial 29 percentage points. Nevertheless, this special consequence on reporting two or more PTEs is also significant among women. In a general population, the time and effort required to use the LHC approach dramatically increase men's reports of earlier life PTEs, but increase both men's and women's reports of experiencing two or more PTEs.

*(Table 2, About here)*

For age, Table 3 shows that the effect of the LHC on reporting PTEs tended to be remarkably similar in older and younger respondents. In general, LHCs are expected to improve reports among older respondents more than they improve reports among younger respondents because older respondents face a more cognitively challenging task in recalling early life events (Axinn et al., 2019). However, in this large-scale study of PTE reporting, we see that the LHC

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approach significantly increases reporting even among younger participants (those under the age of 30, Table 3). These younger respondents were significantly more likely to report any PTE, two or more PTEs, and more total PTEs with the LHC than without. Also important is the fact that the LHC had the same benefits in interviews with older respondents, also significantly increasing their reporting of any PTE, two or more PTEs, and the total number of PTEs experienced. Note that, consistent with the fact that their older age lengthens their exposure to the risk of PTEs, older respondents report more total PTEs experienced than younger respondents. Nevertheless, there were no statistically significant differences in LHC improvements in reporting PTEs by age groups.

(Table 3, About here)

Consistent with expectations on other topics, for PTEs the LHC method appears to have a greater impact among those with less education. In the lower education group, those without an SLC in Nepal increased the percent reporting any PTE by seven percentage points using an LHC approach (also statistically significant, row 1, Table 4). In that group, use of the LHC also significantly increased the total number of PTEs reported (row 3, Table 4). By contrast, among those with an SLC, the LHC had virtually no effect on reports of any PTEs or the number of PTEs. However, this difference by educational level was not statistically significant.

Once again, the reporting of two or more PTEs demonstrates a somewhat different result. Those without an SLC are approximately 20 percentage points more likely to report two or more PTEs when they have an LHC (row 2, Table 4). Those with an SLC are *also* 10 percentage points more likely to report two or more PTEs when they have an LHC (row 2, Table 4). Both of these dramatic increases in reporting two or more PTEs is statistically significant *and* the difference across education levels is also statistically significant. Overall, it appears the strong,

positive association between using an LHC and reports of PTEs is stronger among those with lower levels of educational attainment.

*(Table 4, About here)*

It is also noteworthy that in this Nepalese sample there was a significant overlap in being female and being less educated (particularly among older participants). To examine the potential for the interactions documented here to be independent of one another, we simultaneously tested each of these two-way interactions in a single model predicting each outcome (reporting any PTE, reporting two or more PTEs, and total number of PTEs reported). Results demonstrated that in each case the interaction of LHC with gender was independent of the interaction of LHC with education and the interaction of LHC with age (results not shown, available upon request).

### **Discussion**

Reporting of prior exposure to PTEs is important both as a general example of the potential for underreporting bias and for the specific health consequences of PTEs. Systematic underreporting of PTEs is an important example of retrospective reporting error because these experiences are generally considered memorable personal events. If even these “memorable” events are underreported, then it is highly likely many other previous experiences and conditions are being underreported. Thus, investigation of the LHC influence on reporting of PTEs points toward a general importance of the LHC approach to achieve more complete retrospective reports of a wide range of health-related experiences and conditions.

More complete reporting of prior experience with PTEs is also important because there is substantial prior documentation that PTEs have the potential to shape both physical and mental health, even many years after the PTE was experienced. Thus, both health-related research and

clinical intake benefit from more comprehensive reporting of PTEs. Particularly important is the fact that prior research has established that the experience of two or more PTEs has more significant health consequences than the experience of a single prior PTE (Breslau et al., 1991; Husarewycz et al., 2014; Myers et al., 2015). Therefore, tools that improve the reporting of two or more PTEs are especially valuable.

The large-scale, general population, randomized experiment we report on here demonstrates that interviews with an LHC produce significantly higher reports of lifetime experience of PTEs. The respondents' act of reviewing and recording significant memory anchors helped with the PTE recall. This result is consistent with prior investigation of a specific type of traumatic event: a structured comparison demonstrated the LHC method elicited more reports of lifetime intimate partner violence (IPV) – even more strongly for abuse that happened early in life – than a standard interview survey (Yoshihama, Gillespie, Hammock, Belli, & Tolman, 2005). Here we use randomization to show the LHC method increases reporting across the full range of PTEs. The Yoshihama et al. (Yoshihama et al., 2005) study on IPV was limited to English speaking U.S. citizens. The general population sample from rural Nepal reported on here illustrates that the LHC approach can succeed in settings different than the U.S. – an important finding for the general promise of these tools in international health research.

Particularly striking is the finding that the LHC significantly improved reporting of two or more PTEs. The randomized experiment shows this improvement in reporting is also substantively quite large, adding many more respondents to the high-risk group who have experienced two or more PTEs. Though PTEs are memorable, complete reporting of multiple PTEs is still cognitively demanding enough that attention to the task can significantly and substantially increase reporting of multiple PTEs. Because multiple PTEs have stronger health

consequences than a single PTE does, the LHC can improve our understanding of health risks in both large-scale general population epidemiological research and individual patient clinical intake.

The LHC increased measurement of PTEs among men more strongly than among women. The reasons for this observed sex difference are not entirely obvious. Prior research demonstrates that the LHC approach can increase reports of some health outcomes significantly more for women than for men – for example, as with reporting of prior episodes of major depressive disorder (MDD) in this same experiment in Nepal (Axinn et al., 2019). It is possible that sex differences in the effectiveness of the LHC approach differ outcome by outcome, requiring careful attention to this variability in every LHC application. At least for the retrospective reporting of lifetime exposure to PTEs, the LHC approach appears to make a much bigger difference for men's reporting.

The LHC increased reports of PTEs among both younger and older respondents. This result is somewhat surprising. In general, methodologists expect a stronger effect of the LHC in older ages because recall is especially challenging as individuals age (Axinn & Pearce, 2006). We found significant benefits to those under age 30, with similar improvements in reporting prior PTEs in both age groups. At least with respect to PTEs, the enhanced recall generated by engaging in LHC data collection improves reporting at all ages.

Finally, administration of the LHC increased PTE detection significantly more among those with less education. The dramatically higher recall observed among the less educated is also important because it suggests that the inverse education gradient of health disorders may be due in part to previously underreported health risks that were not observed in prior studies based on lifetime recall without an LHC approach. More thorough detection of health risks, using tools

like the LHC, is a high priority to better understand processes producing education-related social inequality in health, especially mental health.

A key limitation of this study is that the study population is in Nepal. Prior LHC innovations initially designed in Nepal have proved successful elsewhere (Axinn & Pearce, 2006), and the population in Nepal is similar to India and China, as well as many other Asian settings, representing much of the world population. Nevertheless, additional tests of the tool in settings quite different are a high priority. The limitation to only PTEs is also important. Though PTEs are prevalent and an important health risk worldwide, application of the LHC approach to the full range of health risks is another priority. Likewise, though some prior research indicates clinical applications of the LHC approach hold high promise (Caspi et al., 1996), formal testing of the LHC results against existing clinical records of prior health risks would strengthen the empirical basis for clinical applications.

Fully removing the problems of retrospective reporting of exposure to health risks in general, and PTEs specifically, is unlikely to ever be achieved. However, application of the strongest scientific tools for assisting people in their recall has strong merit for both general population research and clinical practice. The LHC tools have proved successful in other areas of science. Through a large-scale randomized trial, we demonstrate the benefits of applying the LHC tool to retrospective reporting of exposures to PTEs. Results demonstrate that use of an LHC in retrospective measurement can significantly increase reports of lifetime experience of PTEs, especially reporting of two or more PTEs. Moreover, the LHC tool is practical for application in both large surveys of the general population and clinical intake of new patients.

**Conflict of Interest Statement:** The authors have no conflicts of interest to report.

**Ethical Approval:** All procedures contributing to this work comply with ethical standards of the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board (HUM00104171) on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. These procedures were also approved by the Nepal Health Research Council (Reg. No. 323/2015). Informed consent was obtained from all individual participants included in the study.

**Data Accessibility Statement:** The data come from the Chitwan Valley Family Study (CVFS) which is archive at the InterUniversity Consortium for Political and Social Research (ICPSR). For more information on accessing using the CVFS please go to <https://cvfs.isr.umich.edu/>. The new data presented here is currently in the process of being archived at ICPSR.



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**Table 1** Percent with any and count of potentially traumatic experiences (PTE), with and without use of a Life History Calendar (LHC)

	Without LHC (n=1404)	With LHC (n=1089)
Any PTE	78.2%	83.8%***
Two or more PTEs	47.8%	64.2%***
Count of PTEs	1.71 (0.04)	2.00 (0.04)***

\* p< 0.05; \*\* p< 0.01; \*\*\* p< 0.001 (tests for significant differences between the two subsamples)

**Table 2** Percent with any and count of potentially traumatic experiences (PTE), by sex, with and without use of a Life History Calendar (LHC)

	Male (n=1141)		Female (n=1352)	
	Without LHC (n=656)	With LHC (n=485)	Without LHC (n=748)	With LHC (n=604)
Any PTE+	71.5%	87.6%***	84.1%	80.8%
Two or more PTEs+	46.3%	75.3%***	49.1%	55.3%*
Count of PTEs+	1.67 (0.06)	2.30 (0.06)***	1.75 (0.05)	1.76 (0.05)

\* p< 0.05; \*\* p< 0.01; \*\*\* p< 0.001 (tests for significant differences between the two subsamples)

+ Gender interaction statistically significant at p<.001

**Table 3** Percent with any and count of potentially traumatic experiences (PTE), by age, with and without use of a Life History Calendar (LHC)

	Age <30 (n=1230)		Age 30+ (n=1263)	
	Without LHC (n=678)	With LHC (n=552)	Without LHC (n=726)	With LHC (n=537)
Any PTE	77.6%	82.4%*	78.8%	85.3%**
Two or more PTEs	45.0%	59.6%***	50.4%	68.9%***
Count of PTEs	1.61 (0.05)	1.82 (0.05)**	1.81 (0.06)	2.18 (0.06)***

\* p< 0.05; \*\* p< 0.01; \*\*\* p< 0.001 (tests for significant differences between the two subsamples)

**Table 4** Percent with any and count of potentially traumatic experiences (PTE), by education, with and without use of a Life History Calendar (LHC)

	No school leaving certificate (n=1634)		School leaving certificate (n=859)	
	Without LHC	With LHC	Without LHC	With LHC
Any PTE	76.9%	84.2%**	81.0%	83.3%
Two or more PTEs+	47.7%	67.5%***	48.1%	58.7%**
Count of PTEs	1.71 (0.05)	2.07 (0.05)***	1.71 (0.07)	1.87 (0.07)

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (tests for significant differences between the two subsamples)

+ Gender interaction statistically significant at p