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ANALYSIS TECHNIQUES APPLIED TO LONGITUDINAL DATA IN PSYCHOLOGY AND HEALTH SCIENCES IN THE PERIOD 1985-2005

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This paper examines the use of the main analytical models applied to longitudinal data in the contexts of psychology and medicine. We carried out a bibliographical review of articles published during the period 1985-2005 in PsycInfo and Medline. The quantity of longitudinal studies increased, following the pattern reported in Singer and Willett's review (2006). The results show that the use of multilevel models increased considerably in the later years of the reviewed period, and that use of the classical models declined. As regards techniques applied to non-metric data, the use of logistic regression increased notably. Other varieties of models, such as structural equation models, time series models and survival models, were used less. However, towards the end of the period studied, the use of structural equation and survival models for analyzing longitudinal data was becoming increasingly popular in psychological and medical research.
Key Words: *Longitudinal studies, Longitudinal data analysis, PsycInfo, Medline, Literature review.*

Este trabajo examina el uso de los principales modelos de análisis aplicados a datos longitudinales en el ámbito de la psicología y medicina. Para ello, realizamos una revisión bibliográfica de los artículos publicados durante el período 1985-2005 en PsycInfo y Medline. Se observa que la cantidad de estudios longitudinales aumenta siguiendo el mismo patrón que en la revisión realizada por Singer y Willett (2006). Los resultados muestran que, en los últimos años, se da un mayor uso de los modelos multinivel con el consecuente decremento de los modelos clásicos. En cuanto a las técnicas aplicadas a datos no métricos, la regresión logística presenta un fuerte aumento. Otra clase de modelos como, por ejemplo, los modelos de ecuaciones estructurales, el análisis de series temporales y el análisis de supervivencia son menos utilizados. Sin embargo, en psicología se constata un ligero incremento de los modelos de ecuaciones estructurales y en medicina se produce un aumento de los análisis de supervivencia a finales del período analizado.
Palabras Clave: *Estudios longitudinales, Análisis de datos longitudinales, PsycInfo, Medline, Revisión bibliográfica.*

Few topics in the methodological-statistical field have received as much attention from research as those studies that take repeated measures of the same units of observation. Such studies are characterized by working with sequenced observations, based both on treatments and on time intervals. When repeated measures are examined from the experimental perspective, the same response variable is observed repeatedly under different treatment conditions. This strategy is followed in order to reduce the error variability, given that the effect of the treatments is assessed through participants' mean response to the different treatments. If, on the other hand, the repeated measures are examined from the time perspective, then what is most important is to analyze the data in terms of some process of change, such as maturation, growth or learning.

As regards the relevance of the repeated measures procedure, and on the basis of a tabulation study on the statistical methods used in the journals of the *American Psychological Association* (APA), Edgington (1974) showed that this procedure is very common in research on behaviour. From a historical point of view, the repeated measures procedure was circumscribed to the experimental context, so that all discussion about analysis models referred to experimental data (Fitzmaurice, Laird & Ware, 2004). However, despite the direct link between the repeated measures technique and experimental studies, it is important to take into account the great impact of the longitudinal approach from the 1970s onwards (Cnaan, Laird & Slasor, 1997; Diggle, Liang & Zeger, 1994; Gregoire, Brillinger & Diggle, 1997; Verbeke & Molenberghs, 1997). It should also be noted that longitudinal studies have been oriented, within the area of developmental psychology, toward the study of intra-individual change in behaviour (processes of change in the individual over time), and toward the study of inter-individual differences in patterns of intra-individual change (Baltes, Reese & Nesselroade, 1988; Datan, Greene & Reese, 1986; Wall & Williams, 1970). One work we cannot avoid mentioning, given its pioneering status, is that of Nesselroade and Baltes (1979), which, within the framework of the developmental field, makes a series of important contributions on methodology, and

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especially on the analysis of longitudinal data. Also relevant is the considerable interest, which began to emerge in the 1980s, in longitudinal research within the field of mental health, with the object of exploring topics such as the natural history of specific types of disorder (Butler & Golding, 1986; Gjessing & Karlsen, 1989; Nicol, 1985; Schulsinger, Mednik & Knop, 1981; Watt, Anthony, Wynne & Rolf, 1984).

In the field of medicine the 1980s also sees the beginning of an increase in longitudinal studies, and such interest sparks a debate on the meaning of the term. For the majority of researchers, principally epidemiologists and demographers, it is synonymous with the study of cohorts, or follow-up studies involving more than two measurements over a long period of time (Chin, 1989; Last, 2000). Around the same time as the growth in interest in longitudinal research there is also an increase in the number of studies proposing analysis procedures for this type of data in clinical work (Dwyer, Feinleib, Lippert & Hoffmeister, 1992; Landis, Miller, Davis & Koch, 1988; Louis, 1988; Twisk, 2003; Ware & Lipsitz, 1988; Zeger & Liang, 1992).

Given the growing interest in the study of processes of change across time, Singer and Willett (2005), in a review of 10 APA journals, show that in 1999, 33% of published studies were longitudinal, compared to a figure of 47% in 2003. In this same study, the authors carried out a search for every year from 1982 to 2002 for the descriptor "longitudinal" in nine databases of the OVID platform, which covers various scientific disciplines. A substantial increase was detected in medicine, biology and physics. On the other hand, social sciences, such as sociology and economics, and also disciplines such as agriculture and zoology, showed only slight increases. In psychology, the increase is also considerable, though smaller than that observed in the field of medicine, in which there are most studies of a longitudinal nature. These data corroborate the spectacular growth in the publication of this type of research. Two main causes for the increase in longitudinal work in applied contexts can be identified: first, the development of advanced analysis techniques, and second, the easy availability of computer programs. These two factors –advances in statistical modelling and greater sophistication in programs– have been responsible more than any other for the increased interest in longitudinal studies, particularly in those areas in which the study of processes of change plays a relevant role, such as the social sciences, psychology, psychotherapy and epidemiology.

More recently, Bono and Arnau (2007), on comparing the number of longitudinal studies with those of cross-sectional studies or works in which measures are taken from a single time point registered in the *PsycInfo* database during the period 1985-2005, found that the highest number was for longitudinal studies. Thus, as Singer and Willett (2003) point out, there is at the present time greater demand for applied longitudinal research. Moreover, there appear not only studies in which the most important characteristic is the repetition of measures of response from the same sample over time, but also cross-sectional repeated measures studies, where each observation uses different samples of subjects from the same population (Ruspini, 2002). Comparison of the actual longitudinal approach with that of the repeated measures cross-sectional one shows that the former is more efficient, more robust for the selection of the model and statistically more powerful (Edwards, 2000; Helms, 1992; Zeger & Liang, 1992).

But in spite of the growing importance of the longitudinal approach, there is still no firm consensus on terminology (Edwards, 2000). Note, for example, that terms such as longitudinal design or study tend to be considered synonymous with repeated measures, panel or cohort designs, and so on. Thus, in the field of sociology, where survey designs are common, longitudinal studies are referred to as panel studies, whilst in the epidemiological and demographic contexts, longitudinal studies are synonymous with cohort or follow-up studies.

There is more and more demand for longitudinal designs today. Consequently, the methodological literature has made considerable progress in the debate on the appropriate methods for handling longitudinal data. Even so, for the majority of those working in the health sciences, the statistical analysis of repeated measures data involves a series of problems: dependency of the measures, subject attrition, and so on, indicating that progress in longitudinal methodology has gone unnoticed to many applied scientists. One factor, mentioned by von Eye (1990), that has contributed to this overlooking of advances in statistical methods in the applied context is the lack of instructions on how to use the computer programs available for applying the new techniques; hence, there is still a gap between advances in statistical methods and their application to empirical studies. With the aim of analyzing how this gap is being closed, and based on the study by Singer and Willett (2005, 2006) showing increasing use of the longitudinal approach in the fields of psychology and medicine, we present a bibliographical review for the period 1985-2005 of the *PsycInfo* and *Medline* databases. Specifically, the prime objective of the present work is to identify the models of analysis that were applied to longitudinal data over this period, and to consider the relevant trends in psychology and social sciences.

LONGITUDINAL STUDIES AND STATISTICAL MODELLING

Longitudinal designs are suitable for studying processes of change across time. Despite their increasingly frequent use in the social and health sciences, a number of difficulties are commonly encountered on analyzing longitudinal data. First of all, the analysis is more complex due to the dependency between the repeated measures of the same observational unit.

Secondly, the researcher often cannot control the circumstances in which the repeated measures are obtained, so that data are sometimes incomplete due to missing scores and/or subjects (Davis, 1998; Menard, 1991). A further difficulty derives from the fact that generally, in applied research, the time intervals tend not to be constant (Hox, 2002). And finally, in follow-up studies, missing data is common, particularly when they extend over many years; this phenomenon is known as sample attrition (Capaldi & Patterson, 1987).

As far as techniques of analysis are concerned, various procedures can be followed. Although longitudinal data have been analyzed with traditional models, such as the univariate analysis of variance (ANOVA) and the multivariate analysis of variance (MANOVA), these models present serious difficulties. The main limitation is the requirement of complete and balanced data. The ANOVA model, with most tradition in the psychological and clinical contexts, is suitable for making comparisons between time intervals. Its main advantage for the analysis of longitudinal data is its technical simplicity, though it does have limitations, given that the data are commonly non-balanced, and there is correlation between the repeated measures. This affects the estimation of standard errors, with the consequent inflation of the Type I error rate (Goldstein, 2003; Murray & Short, 1995). An alternative procedure to the ANOVA for repeated measures data is the MANOVA. It is possible to consider the repeated measures observations, on their being correlated, as multivariate, and consequently to analyze them as such (Rogan, Keselman & Mendoza, 1979). In contrast to the ANOVA, the MANOVA does not start out from a specific assumption about the covariance matrix. The only assumption is that in the case of designs involving more than one group, the covariance matrix must be common to all the groups. When the covariance matrices are not the same, a serious violation occurs in the use of multivariate procedures. If we add to this unequal sample sizes, the problem becomes more acute. It should be borne in mind that the disadvantage of the multivariate procedure is its lower sensitivity for detecting the effect of the "within" variables by comparison with the univariate procedure. Moreover, when the conditions of the covariance matrix are met (sphericity and, in the case of more than one between-subjects level, equality between the matrices of each level), the conventional ANOVA is more powerful than the MANOVA (Albert, 1999; Morrison, 1976; Rogan et al., 1979; Stevens, 1996). Furthermore, with the MANOVA the relations between the repeated measures are not taken into account, and modelling the profiles of the mean responses is precisely what is most important from the longitudinal perspective.

With the aim of dealing with the difficulties of analysis of repeated measures data described above, extensible to models of analysis that include covariables such as the analysis of covariance (ANCOVA), multiple regression and the multivariate analysis of covariance (MANCOVA), models that are more appropriate for this type of data have been developed. If in addition we take into account the use of more powerful calculation instruments, it can be said that effective methods are now available for the analysis of longitudinal data.

The 1970s and early 1980s saw the emergence, in the social science context, of an attempt to apply to longitudinal data the analytical methodology based on structural equation models (Blalock, 1971; Goldberger & Duncan, 1973; Jöreskog, 1979; Kenny, 1979). The 1970s also saw the development of time series models, whose incorporation into the social field can be attributed to Glass, Willson and Gottman (1975). Currently, in the applied context, the aim of time series analyses is to assess the impact or effects of an intervention or measure, such as a campaign to improve quality of life, a new, wide-ranging program or a new law (Stolzenberg & D'Alessio, 2003; White, 2003). Thus, the application of time series models constitutes an important methodological development for program evaluation. With follow-up studies within the health sciences context, especially in clinical trials, we should highlight survival analyses (Marubini & Valsecchi, 1998; Parmar & Machin, 1995). Recent years have also seen the development of various solutions aimed at palliating the problems caused by violation of the assumptions related to the distribution of error probability (Keselman, Carriere & Lix, 1993; Vallejo, Arnau & Ato, 2007; Vallejo & Ato, 2006).

Recently, in social sciences and health research, there has been growing interest in mixed models, also known as random coefficient or random effects models (De Leeuw & Kreft, 1986; Longford, 1993), multilevel models (Goldstein, 2003; Hox, 2002; Snijders & Bosker, 1999) and growth curve models (Goldstein, 1989). In the study carried out between 1995 and 2001 of the articles published in *Medline* on multilevel models in the field of health, Catalán-Reyes and Galindo-Villardón (2003) reported an upward trend. A large part of published works use multilevel analysis in research on public health (Diez-Roux, 2000), such as demographic studies (Entwisle, Mason & Hermalin, 1986), health services research (Leung, Elashoff, Rees, Hasan & Legorreta, 1998; Rice & Leyland, 1996; Sixma, Spreeuwenberg & ven der Pasch, 1998), intervention evaluation (Forster et al., 1998; Hedeker, McMahon, Jason & Salina, 1994), addictions studies (Wang, Siegal, Falck & Carlson, 1998) and research on social determinants of health (Kaplan,1996; Kennedy, Kawach, Glass & Prothrow-Stith, 1998). This increase is due to the fact that one of the principal advantages of mixed models, compared to classical techniques, is the specification of the correct covariance structure of the data observed, which brings greater statistical power on testing the effects of the study (Gill, 2000; Kowalchuk, Keselman, Algina & Wolfinger, 2004; Wolfinger, 1996).

Finally, when the dependent variable is of a non-metric nature,

the alternatives are logistic models, generalized mixed models and models based on generalized estimating equations (Fitzmaurice, Laird & Rotnitzky, 1993; Hosmer & Lemeshow, 1989; Kuchibhatla & Fillenbaum, 2003).

In the present work we shall concentrate on trends in the number of publications that use the corresponding models of analysis, without going into detail about their specific characteristics or the conclusions that can be derived from their application. Each approach requires a certain methodology, as well as a special software program, particularly structural equation models, time series analyses or ARIMA models and mixed models, whose incorporation into repeated measures analysis is more recent. Nor shall we discuss the different statistical programs available.

METHOD

We carried out a bibliographical review from January 1985 to December 2005 of the scientific articles cited in the *PsycInfo* and *Medline PubMed* databases. Currently indexed in the first of these are 2276 APA psychology and psychiatry journals, and in the second, produced by *The National Library of Medicine* and *The National Institutes of Health*, 33,781 journals related to medical research and clinical practice.

Given the lack of standardization of the descriptors for designating the analysis techniques, which depend on the authors and their specialities, in our search we used synonymous key words so as to avoid missing relevant articles. Such is the case of multilevel models, structural equation models and time series analyses, which are designated in different ways.

We selected the descriptor *longitudinal* combined with the descriptors: *ANOVA, MANOVA, ANCOVA, MANCOVA, multiple regression, mixed model, random effects model, multilevel model, growth curve model, structural equation model, latent growth model, latent class model, GEE, logistic regression, ARIMA, time series analysis, survival analysis, Cox regression* and *hazard model*. In turn, these descriptors were crossed with years of publication (1985-2005). In this way we calculated the percentages of articles published according to the different descriptors and year of publication.

RESULTS

Figure 1 shows the percentages of articles identified with the key word "longitudinal" in *PsycInfo* and *Medline* during the period 1985-2005. In the *PsycInfo* database we can see an upward trend for longitudinal studies in the years 1985-1997 and a slight downturn between 1998 and 2003, with a rising trend again from 2004. As regards *Medline*, the increase is constant throughout the period 1985-2005. If instead of annual percentages we consider number of articles of a longitudinal nature (Figure 2), the results show the same pattern as that obtained by Singer and Willett (2006): a greater volume in *Medline* that increases notably in the final years (1999-2005) and a sharp rise in the longitudinal approach in 1997 in both databases.

Longitudinal data require special statistical methods, since repeated measures tend to be inter-correlated and, in turn, longitudinal studies commonly have non-balanced and incomplete data. Nevertheless, the classical techniques of analysis continue to be applied. Figure 3 shows the percentages of articles of a longitudinal nature that apply classical models of analysis in *PsycInfo* and *Medline*, respectively: ANOVA,

FIGURE 1
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)

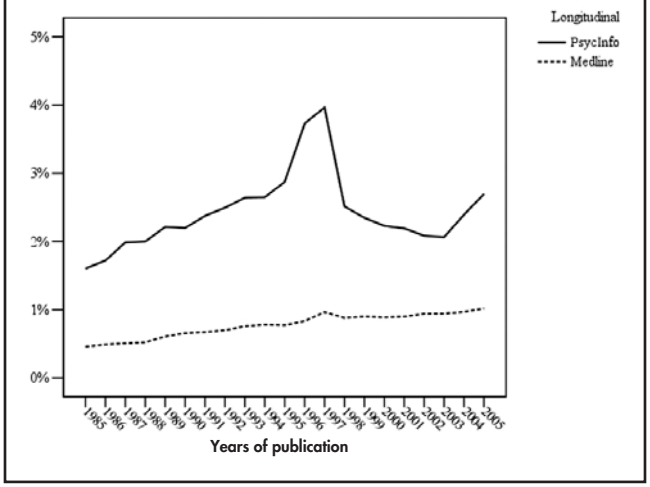
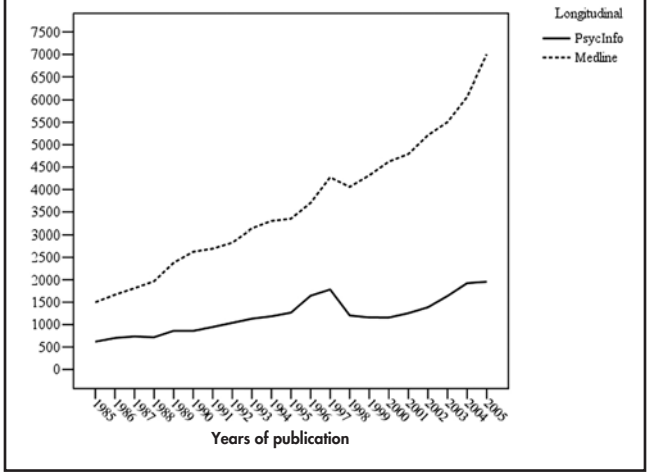


FIGURE 2
NUMBER OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)



MANOVA, ANCOVA, MANCOVA and multiple regression. For ANOVA there is a moderate decrease over time in *PsycInfo*, whilst in *Medline* there is an increase in the period 1990-97 followed by a significant decrease. On the other hand, in both databases, the application of multiple regression remains constant. The rest of the analytical models (MANOVA, ANCOVA and MANCOVA) show a figure of under 1% throughout the entire period.

From the 1980s on, the mixed models begin to be developed as an alternative to the classical analyses of longitudinal data (Goldstein, 1989). Figure 4 shows the percentages of the commonest descriptors of the mixed approach: mixed model, random effects model, multilevel model and growth curve model. All the percentages are very low, both in *PsycInfo* (Figure 4a) and in *Medline* (Figure 4b). However, in the later years we can appreciate a certain increase, as is best reflected in Figure 5a, which groups the percentages of articles indexed in *PsycInfo* that use multilevel models, regardless of their descriptor among those listed for Figure 4, and compares them with the percentages of use of ANOVA and MANOVA. The same occurs, though to a lesser extent, with the *Medline* database (Figure 5b). In either case a decrease can be observed for ANOVA. Singer and Willet (2005, 2006) found this decrease in the repeated measures ANOVA on comparing the percentages of publications from 1999 (40%) and 2003 (29%) in 10 APA journals.

If, on the other hand, instead of percentages we examine the number of publications referring to multilevel models, the increase in these models shows up more clearly, with larger numbers latterly in *Medline* (Figure 6). For example, in 2005

FIGURE 3
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS ANOVA, MANOVA, ANCOVA, MANCOVA AND MULTIPLE REGRESSION (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)

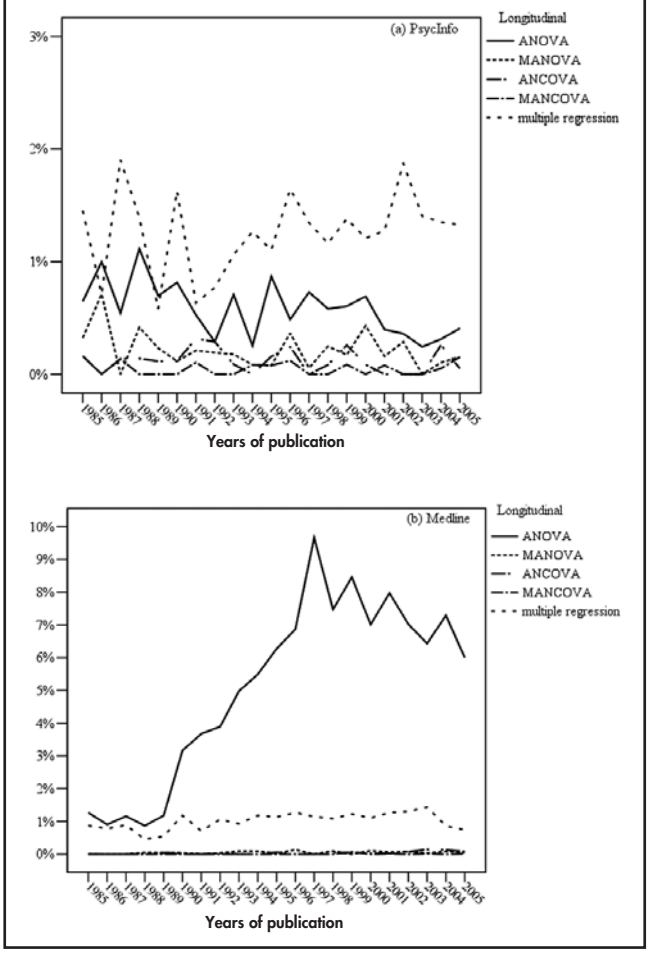
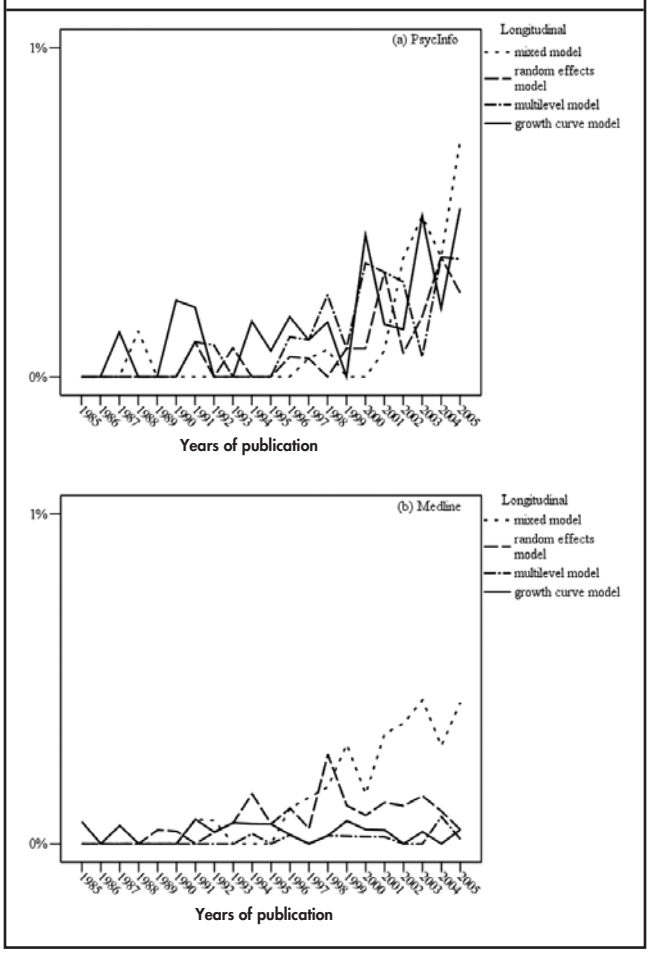


FIGURE 4
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS MIXED MODEL, RANDOM EFFECTS MODEL, MULTILEVEL MODEL AND GROWTH CURVE MODEL (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)



the quantity of articles in *Medline* was almost twice that for *PsycInfo*.

Among the publications of a methodological nature on mixed models, the journal *Multivariate Behavioral Research* is that which most frequently appears in *PsycInfo* from 2000 onwards. Of interest in *Medline* are the journals *Statistics in Medicine* and *Biometrics*, which preferentially publish applications of mixed models to real data. According to Catalán-Reyes and Galindo-Villardón (2003), 55.9% of the articles identified with multilevel methodology in *Medline* correspond to the application of mixed models to a set of data; 9.9% refer to methodological studies, and in the remaining 34.2% of cases it was not possible to ascertain from reading the abstract whether the work was empirical or methodological.

Another of the analytical techniques for longitudinal data is known as the structural equation model. Figure 7 shows the percentages of the descriptors used for designating this class of analysis: structural equation model, latent growth model and latent class model. A slight increase can be observed in the *PsycInfo* database at the end of the 1990s, which is when these models are more commonly applied (Figure 7a). Contributing to this is the journal *Structural Equation Modeling*, which is first published in 1994. In the period 2000-05, the greatest volume of articles applying structural equation models can be found in the journals *Psychology and Aging*, *Developmental Psychology* and *Child Development*. As far as *Medline* is concerned, the percentage of publications is low, indeed, practically zero (Figure 7b).

The most substantial increase in use, of all the analysis techniques considered, corresponds to logistic regression. We can appreciate a sharp growth from 2003 onwards in *PsycInfo* (Figure 8a), and from 1996 in *Medline* (Figure 8b). In the later years, the greatest concentration of articles is in the *Journal of Adolescent Health*, followed by *Archives of General Psychiatry*, *Journal of the American Geriatrics Society* and the *American Journal of Public Health*. To a lesser degree and in a more moderate way, there is a slight increase in the use of generalized estimating equations (GEE) at the end of the period analyzed, and in both databases.

As regards time series analysis, this shows no change over time. The respective percentages are close to zero, in both *PsycInfo* (Figure 9a) and *Medline* (Figure 9b). The main approach for time series analysis is that of the ARIMA model. These models are little used due to their difficulty in identification of the model and the large quantity of observations required before and after a social event or intervention. Bono (2005), in

FIGURE 5
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH ANOVA, MANOVA AND THE DESCRIPTORS REFERRING TO MULTILEVEL MODELS (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)

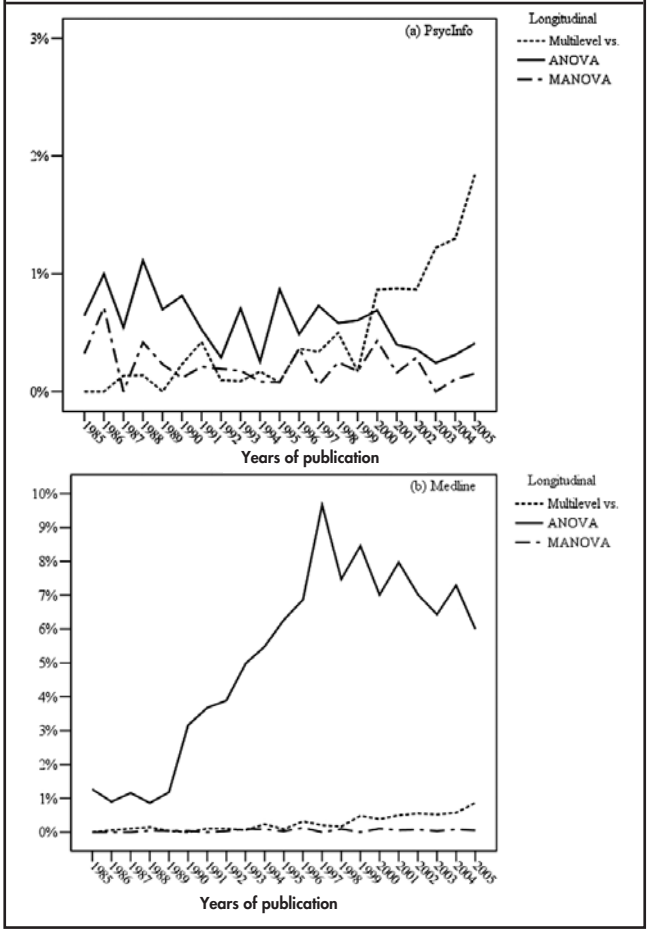
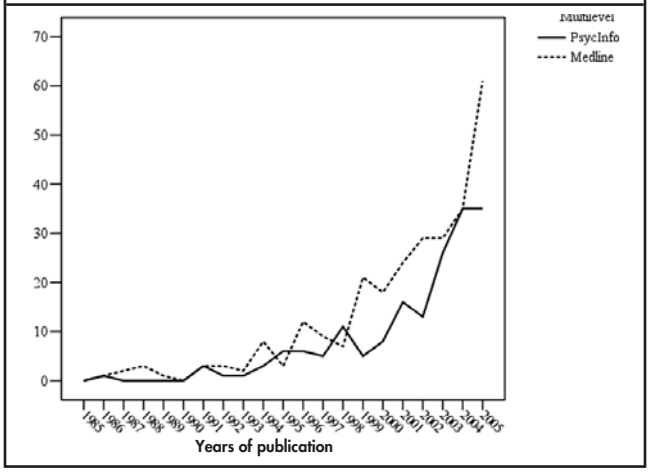


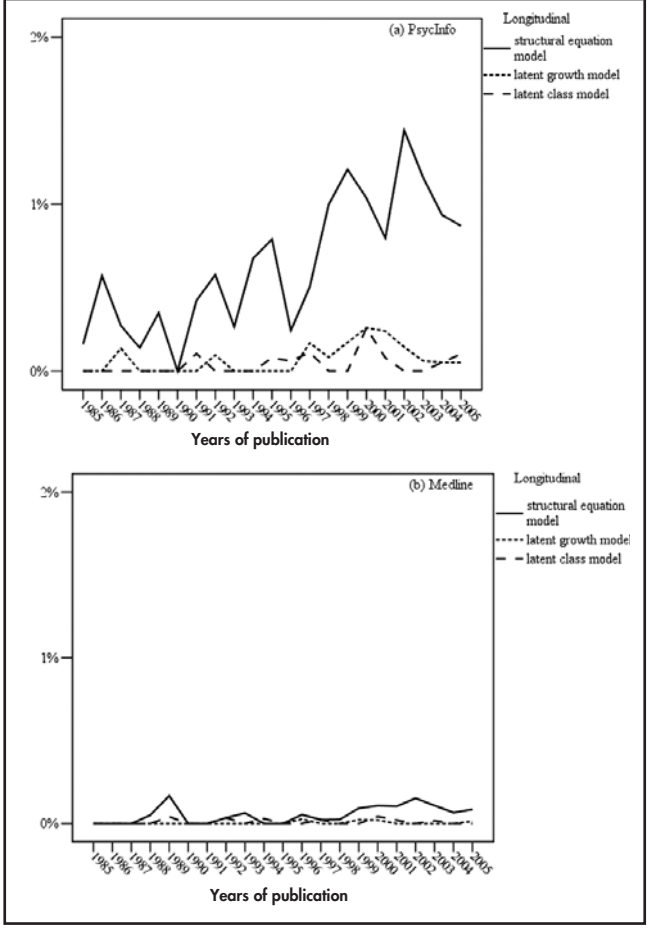
FIGURE 6
NUMBER OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS REFERRING TO MULTILEVEL MODELS (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)



a review carried out for the period 1995-2005, on 20 articles from five APA journals specializing in program evaluation, in which time series designs are used, found just three articles that apply time series analysis.

Finally, the percentages of survival analysis do not surpass 1% in *PsycInfo* (Figure 10a) or 3% in *Medline* (Figure 10b). Likewise, the study by Singer and Willet (2006) shows that survival analyses are little used, with a figure of 2% in 1999 and a constant rate of 5% from 2003 to 2006. As can be seen in Figure 10b, in the field of medicine there is an increase from the early 1990s, with stability from 1997 onwards. It is in this latter period that survival analysis is relevant, followed by Cox regression and the hazard model. These types of analysis are appropriate for follow-up within the clinical field. In this context we should mention the journals *Statistics in Medicine* and the *American Journal of Psychiatry*.

FIGURE 7
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS STRUCTURAL EQUATION MODEL, LATENT GROWTH MODEL AND LATENT CLASS MODEL (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)

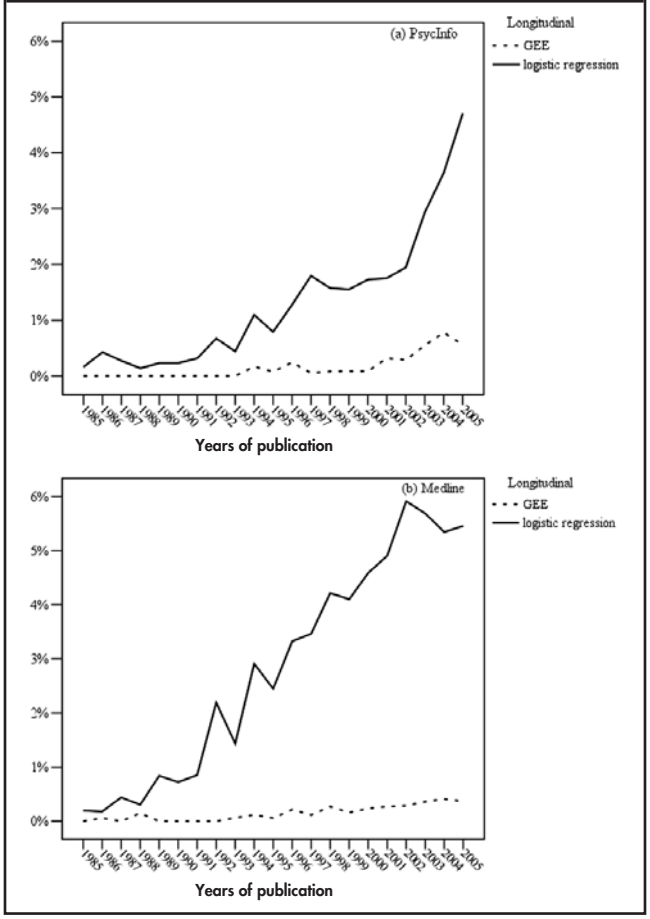


DISCUSSION

The use of classical statistical techniques, such as the repeated measures ANOVA, is tending towards a slow decline in psychology, and a sharper one in the field of medicine. This is due to the fact that recent years have seen the introduction of more powerful calculation instruments and more effective methods for the analysis of longitudinal data. A fairly recently-introduced procedure showing an upward trend is the mixed or multilevel model. The increase in the quantity of publications on the application of multilevel techniques to health data, and of essentially methodological studies in specific areas of health, bears out their use in this context.

The results also show an increase in techniques applied to non-metric data, such as logistic regression. Likewise, the use of structural equation models increases in a constant manner in the field of psychology. As regards survival analyses, there

FIGURE 8
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS GEE AND LOGISTIC REGRESSION (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)



is a notable increase in the medical context; on the other hand, in psychology, the figure remains at 1% or less throughout the reviewed period. There is less use of time series analysis, both in the psychology context and that of medicine.

Before concluding, it is interesting to identify the journals in relation to the different analysis techniques considered, so that we can state in which journals there is an increase in the quantity of the models currently enjoying popularity. The mixed models were prominent in the journals *Multivariate Behavioral Research*, *Statistics in Medicine* and *Biometrics*. As regards logistic regression, the most relevant publication is the *Journal of Adolescent Health*. A journal of reference for structural equation models is *Structural Equation Modeling*, and for survival analyses, *Statistics in Medicine*. On the other hand, it is also interesting to know which specific areas of psychology and medicine have been involved in an increase of the most widely-used models of analysis. In this regard, previous studies have analyzed the use of multilevel methodology in the health sciences (Catalán-Reyes & Galindo-Villardón, 2003; Diez-Roux, 2000).

Finally, it is worthy of mention that we found no references to bibliographical reviews on longitudinal data analysis models that provide an overview of their level of use in psychology and health sciences. We therefore consider the present work to make an important contribution to the field.

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FIGURE 9
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS ARIMA AND TIME SERIES ANALYSIS (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)

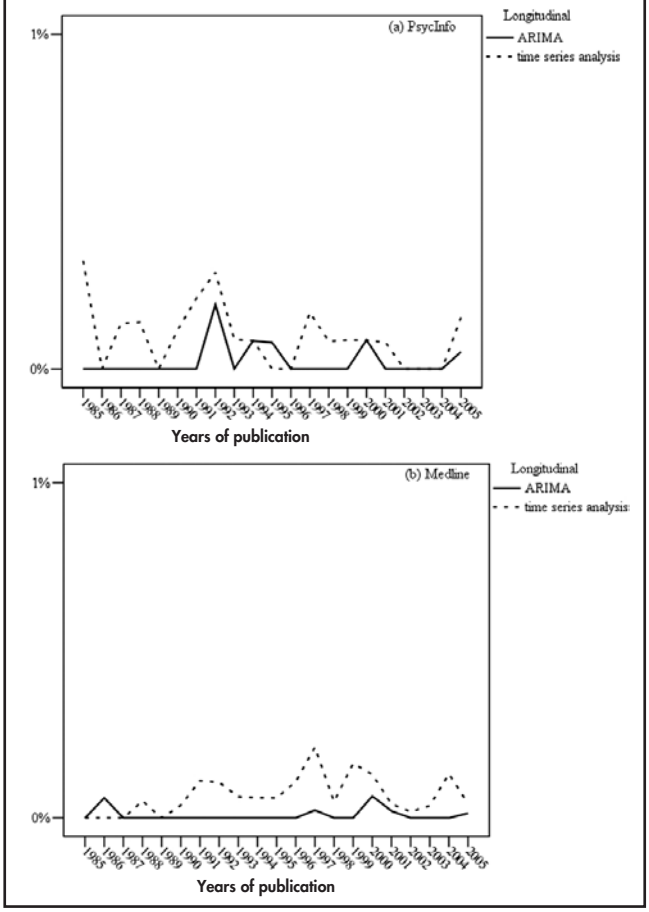
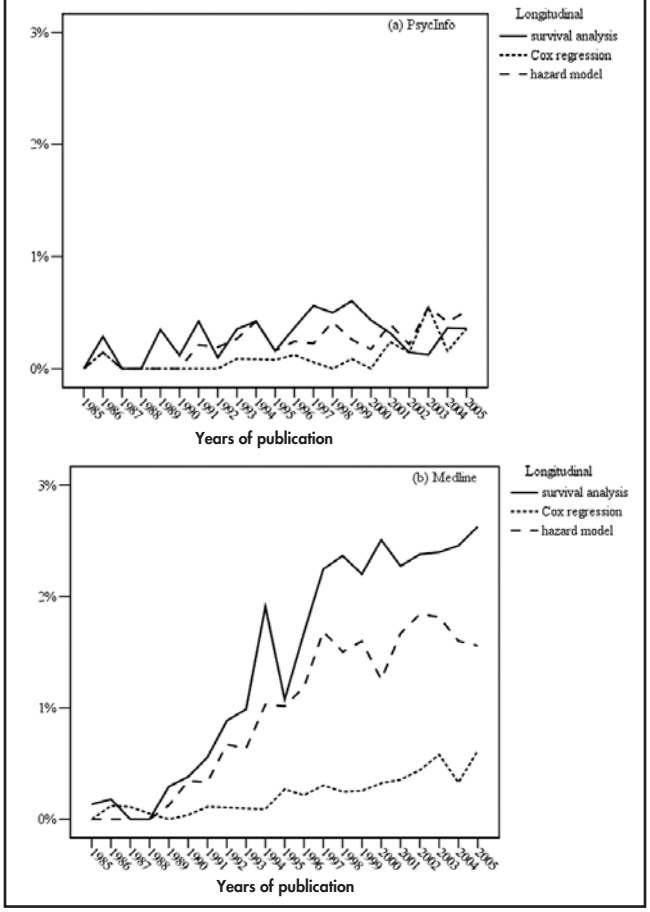


FIGURE 10
PERCENTAGE OF ARTICLES FOUND FOR THE DESCRIPTOR LONGITUDINAL COMBINED WITH THE DESCRIPTORS SURVIVAL ANALYSIS, COX REGRESSION AND HAZARD MODEL (SOURCE: PSYCINFO AND MEDLINE; YEARS OF PUBLICATION: 1985-2005)



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