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Alert: The Dark Side of Chats - Internet without Boundaries	<i>Avshalom Aderet</i>	162
Commentary: Street lights on the dark side of the net.	<i>Meytal Grimland and Alan Apter</i>	167
Author Response	<i>Avshalom Aderet</i>	171
Psychiatric Care in Restricted Conditions for Work Migrants, Refugees and Asylum Seekers: Experience of the Open Clinic for Work Migrants and Refugees, Israel 2006	<i>Ido Lurie</i>	172
Use of Age-Adjusted Rates of Suicide in Time Series Studies in Israel	<i>F. Stephen Bridges and William B. Tankersley</i>	182
Specific Characteristics of Suicide Attempts in Patients with Schizophrenia in Turkey	<i>Özcan Uzun, Lut Tamam Tuncay Özcüler, Ali Doruk and Mehmet Ünal</i>	189
Suicidal Ideation in Patients with Schizophrenia	<i>Cicek Hocaoglu and Zeynep Tekin Babuc</i>	195
Personality Dimensions in Male Patients with Early-Onset Alcohol Dependence Who Seek Treatment	<i>Cuneyt Evren, Ercan Daibudak and Duran Cakmak</i>	204
Community Emergency Psychiatric Service in Israel: A One-Year Experience	<i>Razek Khawaled, Arie Bauer, Paola Rosca, Dafna Helman, Uzi Shai, Alexander Grinshpoon and Alexander M. Ponizovsky</i>	207
Effect of the Selective Norepinephrine Reuptake Inhibitor Reboxetine on Cognitive Dysfunction in Schizophrenia Patients: An Add-on, Double-Blind Placebo-Controlled Study	<i>Michael Poyurovsky, Sarit Faragian, Camil Fuchs and Artashez Pashinian</i>	213
Criminal and Legal Responsibilities in Tourette's Syndrome	<i>Sibel Gullucayir, Mahmut Asirdizer, M. Sunay Yavuz, Yildiray Zeyfeoglu and Tarik Ulucay</i>	221
Reducing Mental Illness Stigma in Mental Health Professionals Using a Web-based Approach	<i>Mahmut Reha Bayar, Burç Çağrı Poyraz, Cana Aksoy-Poyraz and Mehmet Kemal Arıkan</i>	226
Eating Disorder Symptoms Improved by Antireflux Surgery: A Case Report with a Six-Year Follow Up	<i>Defne Eraslan, Ozgur Ozturkand Serhat Bor</i>	231
Book Reviews	<i>Doron Maze, Yoram Barak</i>	236
Hebrew Section		237
News and Notes		240
Abstract		240

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Use of Age-Adjusted Rates of Suicide in Time Series Studies in Israel

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The source of the raw data in this study is the World Health Organization's Mortality DataBase. All analyses, interpretations, and conclusions are solely attributable to the authors of the [published] data and not to WHO, which is responsible only for the provision of the original information.

Abstract: Durkheim's modified theory of suicide was examined to explore how consistent it was in predicting Israeli rates of suicide from 1965 to 1997 when using age-adjusted rates rather than crude ones. In this time-series study, Israeli male and female rates of suicide increased and decreased, respectively, between 1965 and 1997. Conforming to Durkheim's modified theory, the Israeli male rate of suicide was lower in years when rates of marriage and birth are higher, while rates of suicide are higher in years when rates of divorce are higher, the opposite to that of Israeli women. The corrected regression coefficients suggest that the Israeli female rate of suicide remained lower in years when rate of divorce is higher, again the opposite suggested by Durkheim's modified theory. These results may indicate that divorce affects the mental health of Israeli women as suggested by their lower rate of suicide. Perhaps the "multiple roles held by Israeli females creates suicidogenic stress" and divorce provides some sense of stress relief, mentally speaking. The results were not as consistent with predictions suggested by Durkheim's modified theory of suicide as were rates from the United States for the same period nor were they consistent with rates based on "crude" suicide data. Thus, using age-adjusted rates of suicide had an influence on the prediction of the Israeli rate of suicide during this period.

Introduction

Durkheim (1) proposed a sociological theory of suicide which remains the most powerful theory for predicting rates of suicide for a social collectivity. He argued that two broad social characteristics affect rates of suicide. The first characteristic is social integration, i.e., the extent to which members of the society are bound together in social networks or groups (2). According to Durkheim people who are not integrated into the society that they live in are more likely to kill themselves. He argued that people have a certain level of attachment to their groups, which he called social integration. Durkheim (3) reported "We have set up the following three propositions:

Suicide varies inversely with the degree of integration of religious society.

Suicide varies inversely with the degree of integration of domestic society.

Suicide varies inversely with the degree of integration of political society" (p. 208).

The second characteristic is social regulation, i.e., the extent to which the desires, emotions and behaviors of the members of the society are controlled by social norms and customs (2). Durkheim believed immunity [from suicide] was conferred by a single quality common to these three groupings, i.e., that all are strongly integrated social groups. Durkheim (1) reported reaching a general conclusion, i.e., "suicide varies inversely with the degree

of integration of the social groups of which the individual forms a part" (p. 208).

More recently, Johnson (4) reported that it is difficult to empirically distinguish the two characteristics, social integration and social regulation, and he suggested a simpler theory whereby these characteristics were combined into one, i.e., the single characteristic social integration/regulation. Johnson (4) suggested that the relationship between rates of suicide and level of "social integration/regulation" is inversely associated in societies. Thus, one could predict from this modified version of Durkheim's theory that as the rate of suicide decreases, the level of "social integration/regulation" increases and vice versa. Rates of marriage, birth and divorce are used as measures of "social integration/regulation." For example, predictions using Durkheim's modified theory are as follows:

suicide $\uparrow\uparrow$ divorce	or	suicide $\downarrow\downarrow$ divorce (positive association)
suicide $\uparrow\downarrow$ marriage/birth	or	suicide $\downarrow\uparrow$ marriage/ birth (negative or inverse association).

A higher rate of divorce should weaken "social integration/regulation" and be associated with a higher rate of suicide. High rates of marriage and birth should increase "social integration/regulation" and be associated with lower rates of suicide.

Studies of the associations among the rates of marriage, birth, and divorce and incidents of suicide typically use crude rates, i.e., raw data per 100,000 population (5). Lester (2) used gender-specific crude rates of suicide in a 30-year time-series analysis in Israel. He reported that: 1) the male and female rates of suicide between 1960 and 1989 were positively associated with rates of marriage; 2) rates of divorce were positively and negatively correlated with male and female rates of suicide, respectively; 3) the pattern of correlation between rates of birth and male and female rates of suicide was reversed; and finally, that these findings were not consistent with predictions from Durkheim's modified theory of suicide as were the results from the U.S.A. for the same time period (2). The purpose of this study is to determine the effect of using age-standardized rates of suicide, rather than crude rates, when

comparing predictions from Durkheim's modified theory of suicide to actual occurrences of suicide. Here we use a slightly different and longer time period than did Lester (2). And like Lester (2), for comparison purposes, comparable data for the United States are examined.

Methods

Data reporting the number of suicides and population of age cohorts in Israel and the U.S. from 1965 to 1997 were obtained from the World Health Organization's Mortality Database (6). For Israel, the number of suicides among the Jewish population 15 years of age and older for 1965-1976 was utilized to be consistent with Lester (2). For the years 1977 to 1997, the Israeli population 15 years of age and older was used. Crude rates of marriage, birth, and divorce were obtained from the United Nations (7) as were population data for 1965 to 1974.

Table 1. *Standard Population Distribution (%)*

Age group	Segi ("world") standard
0-4	12.00
5-9	10.00
10-14	9.00
15-19	9.00
20-24	8.00
25-29	8.00
30-34	6.00
35-39	6.00
40-44	6.00
45-49	6.00
50-54	5.00
55-59	4.00
60-64	4.00
65-69	3.00
70-74	2.00
75-79	1.00
80-84	0.50
85+	0.50
Total	100.00

Table 2. Rates of Marriage, Birth, Divorce and Suicide for Israel and the United States (per 100,000 per year)

	Marriage	Birth	Divorce	Suicide		Marriage	Birth	Divorce	Suicide		
				male	female				male	female	
Israel						United States					
1965	7.9	25.8	0.9	10.4	7.5	1965	9.3	19.4	2.46	22.8	8.4
1966	7.9	25.5	0.85	11.4	6.4	1966	9.5	18.4	2.54	22.6	8.1
1967	7.3	23.7	0.78	11.7	6.4	1967	9.7	17.8	2.63	22.1	8.4
1968	8.3	24.9	0.85	12.6	8.6	1968	10.4	17.5	2.91	21.8	8.1
1969	8.9	25.6	0.82	10.9	7.7	1969	10.6	17.8	3.15	22.5	8.6
1970	8.9	27.2	0.82	9.1	5.8	1970	10.6	18.4	3.45	23.3	9
1971	9.2	28	0.81	9.6	7.7	1971	10.6	17.2	3.72	23.1	9.3
1972	9.3	27.2	0.85	10.8	8.2	1972	10.9	15.6	4.02	24	9.2
1973	9	27	0.81	8.7	7.3	1973	10.8	14.8	4.32	24.1	8.8
1974	9.6	27.6	0.82	9.1	4.8	1974	10.5	14.8	4.57	24.3	8.8
1975	9.4	27.7	0.9	12.2	8.8	1975	10	14.6	4.8	25.1	9
1976	8.3	28	0.93	13.1	7.7	1976	9.9	14.6	4.97	24.4	8.7
1977	8.1	26.4	1.02	12.8	6.8	1977	9.9	15.1	4.95	25.9	8.8
1978	7.9	25.1	1.06	9.8	6.5	1978	10.3	15	5.08	24.2	8.1
1979	7.9	24.7	1.11	13.3	6.5	1979	10.4	15.6	5.25	23.9	7.8
1980	7.6	24.3	1.14	11.8	5.4	1980	10.6	15.9	5.22	23.7	7
1981	7.5	23.6	1.17	10.1	5.4	1981	10.6	15.8	5.27	23.8	7.4
1982	7.3	24	1.16	9.3	5.6	1982	10.6	15.9	5.04	24.3	7.1
1983	7.5	24	1.23	11.7	5.3	1983	10.5	15.6	4.94	24.1	6.8
1984	7.2	23.7	1.16	10.6	4.8	1984	10.5	15.6	4.95	24.6	6.8
1985	6.9	23.5	1.16	11	4.9	1985	10.1	15.8	4.99	24.8	6.4
1986	7	23.1	1.18	12.5	6.2	1986	10	15.6	4.81	25.5	6.7
1987	6.9	22.7	1.19	13.1	4.6	1987	9.9	15.7	4.8	25.3	6.5
1988	7	22.6	1.26	14.5	5.6	1988	9.8	16	4.83	24.8	6.2
1989	7	22.3	1.26	16	5.7	1989	9.7	16.4	4.7	24.7	5.9
1990	6.8	22.2	1.36	13.7	5	1990	9.8	16.6	4.7	25.2	5.9
1991	6.5	21.4	1.27	15.3	5.2	1991	9.4	16.3	4.7	24.9	5.7
1992	6.4	21.5	1.37	15.6	5.3	1992	9.3	16	4.76	24.3	5.6
1993	6.5	21.3	1.39	14.7	4.7	1993	9	15.5	4.6	24.6	5.6
1994	6.7	21.2	1.52	15.9	5.1	1994	9.1	15.2	4.57	24.7	5.4
1995	6.1	21	1.6	13.2	4.5	1995	8.9	14.8	4.45	24.6	5.3
1996	6.3	21.3	1.51	11.1	3.2	1996	8.8	14.8	4.33	23.8	5.3
1997	6.5	21.4	1.56	14.1	3.1	1997	8.9	14.5	4.34	23	5.3

Lester (2) noted the possibility of age composition effects and suggested that future research might benefit from using age-adjusted rates of suicide. These standardized rates control for national differences in age structure or composition. To accomplish this, the authors computed gender-specific age-standardized rates of suicide for Israel and the U.S. using the direct method of standardization (8, 9). To calculate the age-standardized rate for each gender separately, the World Standard Population prepared by Segi (10) is used as the "standard population" (Table 1). This "standard population" was modified to consist of those aged 15 years and older.

There are several techniques for adjusting age-specific rates. Among them are direct and indirect standardization, the geometric mean, equivalent average death rates, life table rates, Yerushalmy's index, cumulative death rates, absolute probabilities of death and the comparative mortality index (11). These researchers reported that due to "the increasing availability of age-specific rates, the use of direct age standardization has become the predominant technique in most applications of demography and epidemiology. Direct standardization yields a standardized or age-adjusted death rate, which is a weighted average of the age-specific rates, for each of the populations to be compared. The weights applied represent the relative age distribution of the arbitrary external population (the standard). This provides, for each population, a single summary rate that reflects the number of events that would have been expected if the populations being compared had had identical age distribution. Symbolically, the directly standardized mortality rate for populations *A* and *B* are given by the following equations:

$$DSR_a = \sum r_{ia} \left(\frac{n_{is}}{\sum_i n_{is}} \right)$$

$$DSR_b = \sum r_{ib} \left(\frac{n_{is}}{\sum_i n_{is}} \right)$$

where *n_{is}* is the mid-year population in the *i*th age group of the *standard* population, *r_{ia}* and *r_{ib}* are the death rates in age group *i* in populations *A* and *B*, respectively" (11, p. 3).

The data were analyzed using the statistical package, Statgraphics Centurion XV (12), to produce

simple Pearson correlation coefficients and simple multiple linear regression estimates for time-series data. Serial autocorrelation was detected in three out of the four data sets, therefore the Cochrane-Orcutt method was used to correct for this serial autocorrelation.

Results

The data for the study are displayed in Table 2, and the results are given in Table 3. Lester's (2) findings also appear in Table 3 in parentheses for comparison. It is interesting to note that the Israeli male rate of suicide increased between 1965 and 1997 (.63, $p < .001$), while the Israeli female rate of suicide decreased during the same time period (-.77, $p < .001$).

With respect to the relationships among suicide, marriage, birth rates and divorce, the Israeli male rate of suicide was negatively associated with rates of marriage and birth and positively associated with the rate of divorce. This is to say, the Israeli male rate of suicide was lower in years when rates of marriage and birth were higher while rates of suicide were higher in years when rates of divorce were higher. The simple Pearson correlations in Table 3 differ from the results of Lester (2), who reported that domestic integration was not associated with the Israeli male rate of suicide. In the present study, the relationships indicated by these simple correlations for Israeli males conform to the expected relationships suggested by Durkheim's modified theory.

The Israeli female rate of suicide was positively associated with rates of marriage and birth and negatively associated with rate of divorce. Like Lester's (2) results, domestic social integration was positively and significantly associated with the Israeli female rate of suicide, i.e., Israeli women have higher rates of suicide in years when marriage and birth rates are higher and lower suicide rates in years when rates of divorce are higher. The relationships indicated by these simple correlations for Israeli females are opposite the expected relationships suggested by Durkheim's modified theory.

For the U.S., we find that the male rate of suicide was negatively associated with both the rates of marriage and birth while being positively

associated with rate of divorce; however, only the association with the rate of marriage did not reach significance. Like Lester (2), American male rates of suicide conformed to Durkheim's modified theory regarding domestic integration.

The U.S. female rate of suicide was positively associated with both rates of marriage and birth and negatively associated with rate of divorce. The association with rate of birth, however, did not reach significance. The result is opposite the relationships

Table 3. *Domestic Integration and Suicide in Israel and the U.S., 1965-1997†*

Constant		Divorce rate	Marriage rate	Birth rate	Durbin-Watson	R ²
Pearson Correlations suicide rates††:						
Israeli male		0.62*** (0.19)	-0.62*** (0.03)	-0.65*** (-0.10)		
Israeli female		-0.77*** (-0.63***)	0.75*** (0.39*)	0.75*** (0.50**)		
U.S. male		0.77*** (0.65***)	-0.11 (0.04)	-0.61*** (-0.44*)		
U.S. female		-0.38* (-0.32)	0.67*** (0.18)	0.29 (-0.01)		
Linear Regressions suicide rates						
Israeli male	20.54* (8.82)	1.89 (4.12)	0.15 (1.37)	-0.48 (-0.39)	1.2 (1.06)	.43 (0.12)
Israeli female†††	5.70 (15.18)	-2.99* (-9.34**)	0.35 (-1.05)	0.04 (0.45)	2.14 (1.06)	.62 (0.44)
U.S. male	21.97*** (35.59***)	1.02*** (0.92***)	-0.33 (-1.29***)	0.06 (-0.11)	1.07 (1.04)	.64 (0.73)
U.S. female	1.60 (13.31*)	-1.21*** (-1.10***)	1.70*** (0.45)	-0.37 (-0.32*)	0.58 (0.43)	.69 (0.50)
Cochrane-Orcutt Method suicide rates						
Israeli male	13.73 (14.41)	3.87 (4.64)	0.57 (2.59*)	-0.42 (-1.02)	1.82 (1.74)	.23 (0.35)
Israeli female	5.70 (19.70)	-2.99* (-6.83)	0.35 (1.55)	0.04 (-0.67)	2.14 (1.98)	.62 (0.70)
U.S. male	20.91*** (34.89***)	1.08** (0.83*)	-0.31 (-1.15**)	0.09 (-0.13)	1.82 (2.25)	.40 (0.79)
U.S. female	3.51 (-23.58)	0.57 (0.16)	-0.20 (-0.29)	-0.02 (-0.21)	2.22 (2.17)	.07 (0.86)

† Lester's (1997) findings appear in parentheses

†† All Pearson correlation coefficients reported by Lester (1997) were shifted to the right one column

††† no indication of serial autocorrelation

* two-tailed $p < .05$

** two-tailed $p < .01$

*** two-tailed $p < .001$

suggested by Durkheim's modified theory. Lester (2) reported the American female rates of suicide were not significantly related to the three measures of domestic social integration, i.e., marriage, birth and divorce.

In simple regression estimates, the Durbin-Watson statistics indicate that each data set except Israeli females demonstrates serial autocorrelation. As noted above, the Cochrane-Orcutt method was used to correct for this serial autocorrelation. Further, the success of the simple linear regression prediction model was better for Israeli female rates of suicide than for Israeli male rates of suicide, i.e., the R^2 for females was higher than that for males.

In the present study, the corrected regression coefficients indicate that the Israeli female rate of suicide remained positively associated with the rates of marriage and birth and negatively associated with the rate of divorce. The coefficient for the rate of divorce remained statistically significant unlike the coefficients for marriage and birth. This finding for divorce was unlike that reported by Lester (2). Results suggest that the Israeli female rate of suicide was lower in years when rate of divorce is higher, and thus is opposite that suggested by Durkheim's modified theory. These results may indicate that divorce affects the mental health of Israeli women as suggested by their lower rate of suicide. Perhaps the "multiple roles held by Israeli females creates suicidogenic stress" and divorce provides some sense of stress relief, mentally-speaking (13, p. 111).

For American males and females, the results of the corrected regressions, using the Cochrane-Orcutt method, indicate conformity to Durkheim's modified theory with one exception, i.e., the coefficient for the rate of birth for males was slightly positive, although not statistically significant. Overall, this was in agreement with the findings of Lester (2).

Discussion

Based on the findings in this study, the use of age-adjusted rates of suicide rather than crude rates of suicide appears to affect the results of time-series analyses when applied to existing suicide data. While it is true that our initial correlations for rates

of suicide for Israeli males conform to predictions made from using Durkheim's modified theory, this was not confirmed using regression analysis. That is, the regression coefficients for the male rate of suicide and the male rate of marriage changed from positive to negative. This was not the case for the Israeli females, however, as both initial correlations and the subsequent regression analyses produce results that are opposite to the predictions suggested by the modified theory. Lester (2) suggests that the theory may not apply to discrete groups such as Israeli females or, alternatively, suicides of Israeli females may be *altruistic* or *fatalistic*, an event that occurs outside the constraints of Johnson's (4) modification to Durkheim's original theory. Here, as suggested by Lester (2), suicide may have occurred as a consequence of too much social integration/regulation as opposed to too little.

The standardized rates of suicide for Israeli males significantly increased between 1965 and 1997 while the rates for females significantly decreased during the same time period. This is consistent with the results of others (14) who reported that more males in Israel committed suicide than did females in all age groups for the time period of 1984 to 1994. Moreover, Lester's (5) report of a decrease in Israeli female rates was consistent with other reports of statistically significant declines in female rates of suicide among countries like Australia, Chile, West Germany, and the United States from 1970 through 1984 (15). Lester also reported that selected other countries had similar, although non-significant declines, including Canada, England and Wales, Japan, and Sweden (15).

There are methodological limitations to this study that suggest the need for additional research. For example, rates of *suicide attempts* may be more relevant for use with the modified Durkheim theory than the actual record of successful attempts. That is, problems with the determination of death due to various pressures, open or surreptitious, may result in suicide being reported as something else. Such reporting bias may be because suicide is highly stigmatizing for family survivors and/or those living in small communities (14).

Likewise, sectional demographic differences within political boundaries, but not taken into account in this study, might affect results in such a

manner as to be enlightening if taken into account. For example, Lubin et al. (14) reported, "the Israeli population to be characterized by ethnic diversity, with a multi-religious, multi-national mosaic of Jews and Arabs. These subgroups vary in their suicidal behavior" (p. 123).

It is clear that social variables may determine Israeli rates of suicide. Measures of economic activity such as unemployment, female labor force participation, and gross national product per capita have been found to be associated with societal rates of suicide in many countries (16). The composition of Israel's population has changed over time due to emigration and demographic changes. For example, since 1990 there has been an increase in the number of Jews emigrating from the Soviet Union and Ethiopia to Israel (17). In addition, demographic changes other than age composition of the population taken into account in this study may have affected the standardized rates of suicide developed here. Tensions resulting from political upheaval and violence within and directed toward Israel may be a particularly important factor with respect to the Israeli historical rate of suicide (17).

While it is clear that additional research is required to isolate and identify sufficiently the factors accounting for varying suicide rates in different populations, it seems very reasonable that use of age-adjusted rates such as those described here provide additional insight into the inquiry. And, since the use of age-adjusted rates of suicide here result in important differences in results from those based upon crude rates, it is suggested that future investigators consider using both types of rates when available.

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