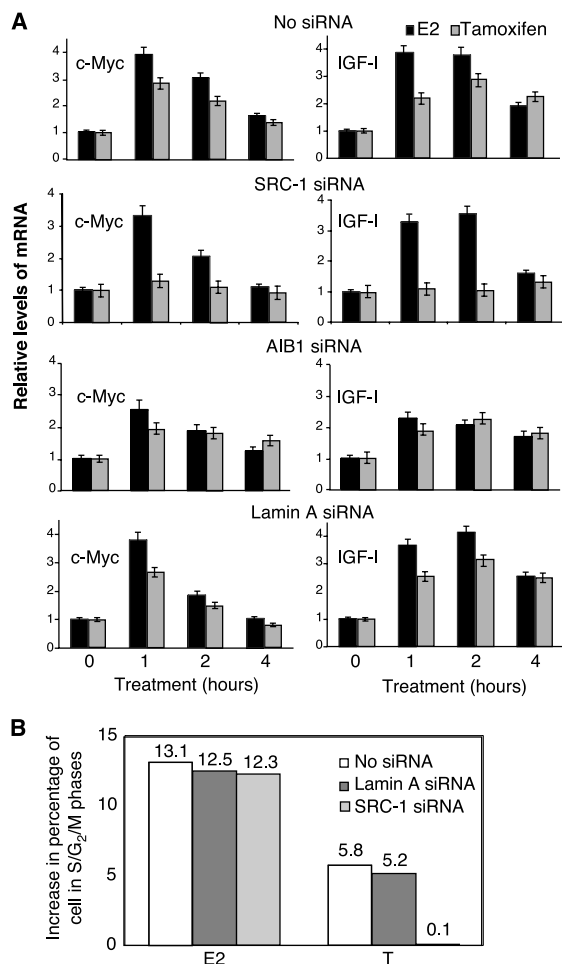


REPORTS

**Fig. 4. (A)** The effect of SRC-1 silencing on tamoxifen-stimulated gene expression in Ishikawa cells. Ishikawa cells were seeded into 10-cm polystyrene cell-culture dishes (Becton Dickinson, Franklin Lakes, NJ) with phenol red-free DMEM supplemented with 5% charcoal-dextran-stripped FBS for 24 hours and transfected with 5  $\mu$ g/dish of double-stranded, short interfering RNAs (siRNAs) for SRC-1, AIB1, or lamin A/C using the Oligofectamine Reagent (Invitrogen Corp.). Single-stranded RNAs were synthesized by Dharmacon Research, (Lafayette, CO). Before transfection, single-stranded RNAs were incubated at 90°C for 1 min, followed by annealing in annealing buffer (100 mM potassium acetate, 30 mM Hepes-KOH, pH 7.4, and 2 mM magnesium acetate) at 37°C for 2 hours. Forty-eight hours after transfection, cells were treated with 100 nM of 17 $\beta$ -estradiol (E2), 1  $\mu$ M of 4-hydroxytamoxifen (Tamoxifen), or 1  $\mu$ M of raloxifene. The TRIzol reagent was used to extract total RNAs for analyzing c-Myc and IGF-I mRNA by real-time RT-PCR. Transfection efficiency was monitored by cotransfection with an *Escherichia coli lacZ* construct. **(B)** The effect of SRC-1 silencing on tamoxifen-stimulated cell-cycle entry. Ishikawa cells grown in phenol red-free DMEM supplemented with 5% charcoal-dextran-stripped FBS were cotransfected with 5  $\mu$ g of SRC-1 siRNAs and a green fluorescent protein construct (pEGFP, Clontech) or cotransfected with lamin A siRNA and pEGFP. Forty-eight hours after transfection, cells were treated with 100 nM of 17 $\beta$ -estradiol (E2) or 1  $\mu$ M of 4-hydroxytamoxifen (T) for another 16 hours. Cells were then collected and resuspended in PBS with 2% glucose and 3% paraformaldehyde. After permeabilization with ethanol, cells were stained with propidium iodide solution (69  $\mu$ M propidium iodide and 38 mM sodium citrate). Cell-cycle data were collected with FACScan (Becton Dickinson Immunocytometry System) and analyzed with ModFit LT (Verity Software House, Topsham, ME).



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# Television Viewing and Aggressive Behavior During Adolescence and Adulthood

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Television viewing and aggressive behavior were assessed over a 17-year interval in a community sample of 707 individuals. There was a significant association between the amount of time spent watching television during adolescence and early adulthood and the likelihood of subsequent aggressive acts against others. This association remained significant after previous aggressive behavior, childhood neglect, family income, neighborhood violence, parental education, and psychiatric disorders were controlled statistically.

Three to five violent acts are depicted in an average hour of prime-time television and 20 to 25 violent acts are depicted in an average hour of children's television (1-3).

Research has indicated that viewing television violence is associated with aggressive behavior (4-6). However, important questions regarding the nature and direction of

this association remain unanswered. Several theories hypothesize that television violence contributes to the development of aggressive behavior (7, 8). An alternative hypothesis is that some or all of the association is due to a preference for violent television programs among aggressive individuals (9). Research has provided support for both hypotheses (10). It has also been hypothesized that certain environmental characteristics, such as living in an unsafe neighborhood and being raised by neglectful parents increase the likelihood of both aggressive behavior and viewing televised violence. This hypothesis has not been extensively investigated.

Experimental and longitudinal studies have provided considerable support for the hypothesis that children's viewing of televised violence is associated with subsequent increases in aggressive behavior (11). However, most of these studies have inves-

## REPORTS

tigated short-term increases in aggression, and few studies have followed youths for more than a year. A single study has investigated the association between childhood television viewing and aggressive behavior during adulthood. The findings of that study indicated that a preference for violent television programs during childhood predicted aggression during late adolescence (12) and early adulthood (13). However, there was a high attrition rate, and the amount of time spent watching television was not assessed.

To investigate whether television viewing during adolescence and adulthood is associated with an increased likelihood of aggressive behavior, it is necessary to assess television viewing and aggressive behavior repeatedly during adolescence and adulthood, and to assess environmental and personal characteristics that could underlie this association in a large, representative, community-based sample. We report findings of the Children in the Community Study, a community-based longitudinal investigation that meets these methodological criteria.

Participants were 707 families with a child (51% male) between the ages of 1 and 10, randomly sampled from two counties in northern New York State, for whom data were available through 1991–93 regarding television viewing, and through 2000 regarding aggressive behavior. Interviews were conducted with these families in 1975, 1983, 1985–86, and 1991–93 (14). The youths in the study, randomly selected

from age-eligible offspring, were administered questionnaires that assessed a wide range of aggressive acts in 2000. In 2000, data were also obtained from New York State and Federal Bureau of Investigation records regarding arrests and charges for adult criminal behavior. The participating families generally represented families in the northeastern United States in socioeconomic status and most demographic variables, and they reflected the sampled region with high proportions being Catholic (54%) and White (91%).

The mean age of the youths was 5.8 (SD = 3) in 1975, 13.8 (SD = 3) in 1983, 16.2 (SD = 3) in 1985–86, 22.1 (SD = 3) in 1991–93, and 30.0 (SD = 3) in 2000. Study procedures were approved according to appropriate institutional guidelines. Written informed consent was obtained after the interview procedures were fully explained. Youths and their mothers were interviewed separately by extensively trained and supervised lay interviewers who were blind to the responses of the other informant. If the reports of the two informants differed with regard to television viewing, the higher of the two reports was used. Additional information regarding the study methodology is available from previous reports (15).

The parent and youth versions of the Diagnostic Interview Schedule for Children (DISC-I) (16) were administered to assess offspring psychiatric disorders and aggressive or criminal behavior in 1983 and 1985–86. An age-appropriate modification of the DISC-I was administered to the offspring in 1991–93. Mothers and youths were both interviewed in 1983 and 1985–86 because the use of multiple informants tends to increase the reliability and validity of psychiatric diagnoses among children and adolescents (17, 18). Aggressive acts and psychiatric symptoms were considered

present if reported by either informant. The reliability and validity of the DISC-I as used in the present study are comparable to those of other structured interviews (19). The prevalence of aggressive behavior in the present sample is consistent with the findings of previous community-based studies (20–22).

Low family income was defined as mean income below the U.S. Poverty Level. Low parental education was defined as less than a high school education for either parent. Verbal intelligence (IQ) was assessed in 1983 and 1985–86 by using a picture-vocabulary test (23). IQ scores were averaged, and scores below 90 were considered to be low. Childhood neglect was assessed from data from a central registry, from retrospective self-reports obtained in 1991–93, and from the maternal interviews (24). Additional items in the study protocol assessed neighborhood characteristics, peer aggression, and school violence (25).

Childhood neglect, growing up in an unsafe neighborhood, low family income, low parental education, and psychiatric disorders were significantly associated with time spent watching television at mean age 14 and with aggressive behavior reported at mean age 16 or 22 [Web table 1 (26)]. Age and sex were significantly associated with aggressive behavior, but not with time spent watching television at mean age 14.

There were significant associations between television viewing during early adolescence and subsequent aggressive acts against other persons after the covariates that were significantly associated with television viewing and aggressive behavior were controlled statistically (27) (Table 1). Television viewing at mean age 14 remained significantly associated with any subsequent aggressive act against another person after controlling for prior (AOR =

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**Table 1.** Television viewing at mean age 14 and aggressive acts reported at mean age 16 or 22 (*n* = 707).

Aggressive acts reported at mean age 16 or 22	Study group	Television viewing at mean age 14			Adjusted odds ratio (95% CI) <sup>‡</sup>
		<1 hour/day % ( <i>n</i> )	1 to 3 hours/day % ( <i>n</i> )	≥3 hours/day % ( <i>n</i> )	
Assault or physical fights resulting in injury	Total sample	5.7 (5 of 88)*	18.4 (71 of 386)	25.3 (59 of 233)	1.57 (1.13–2.16) <sup>†</sup>
	Males	8.9 (4 of 45)*	27.5 (55 of 200)	41.7 (48 of 115)	1.95 (1.30–2.94) <sup>†</sup>
	Females	2.3 (1 of 43)	8.6 (16 of 186)	9.3 (11 of 118)	1.23 (0.72–2.54)
Robbery, threats to injure someone, or weapon used to commit a crime	Total sample	3.4 (3 of 88)*	9.6 (37 of 386)	14.6 (34 of 233)	1.58 (1.01–2.46) <sup>†</sup>
	Males	6.7 (3 of 45)	14.0 (28 of 200)	20.9 (24 of 115)	1.46 (0.84–2.53)
	Females	0 (0 of 43)	4.8 (9 of 186)	8.5 (10 of 118)	2.44 (0.97–6.16)
Any aggressive act against another person	Total sample	5.7 (5 of 88)*	22.5 (87 of 386)	28.8 (67 of 233)	1.58 (1.16–2.16) <sup>†</sup>
	Males	8.9 (4 of 45)*	32.5 (65 of 200)	45.2 (52 of 115)	1.92 (1.28–2.88) <sup>†</sup>
	Females	2.3 (1 of 43)	11.8 (22 of 186)	12.7 (15 of 118)	1.25 (0.70–2.22)

\*Significantly lower level of subsequent aggression in comparison with individuals who spent more time watching television at mean age 14. <sup>†</sup>Significant association after controlling for the covariates that were significantly associated with television viewing and subsequent aggression. NOTE: Odds ratios indicate the average increase in the odds for subsequent aggression associated with an increase in the level of television viewing (e.g., from <1 hour to 1 to 3 hours per day of television viewing). <sup>‡</sup>95% confidence interval.

REPORTS

1.86; CI: 1.32-2.61) and subsequent television viewing (AOR = 1.46; CI: 1.05-2.60). Television viewing at mean age 14 was not associated with risk for subsequent property crimes, including arson, vandalism, or theft. Time spent watching television during early adolescence was associated with risk for subsequent aggressive acts among youths with and without a history of aggressive behavior (Fig. 1). The statistical interactions of television viewing with sex and previous aggression were not significantly associated with subsequent aggressive behavior.

In the male subsample, television viewing at mean age 14 was associated with subsequent assaults or fights resulting in injury and any aggressive act against another person. Although the prevalence of subsequent aggressive acts increased in relation to television viewing at mean age 14 among both the male and female subsamples (Fig. 1), the association did not attain statistical significance in the female subsample (28). The association between

television viewing at mean age 14 and any aggressive act against another person was significantly stronger in the male subsample than in the female subsample ( $z = 2.17$ ;  $P = 0.03$ ).

There was a significant association between time spent watching television at mean age 22 and subsequent aggressive acts against other persons after the covariates were controlled statistically (Table 2). This association remained significant after controlling for prior television viewing (AOR = 1.65; CI: 1.07-1.99). Television viewing at mean age 22 was not associated with risk for subsequent property crimes, including arson, vandalism, or theft.

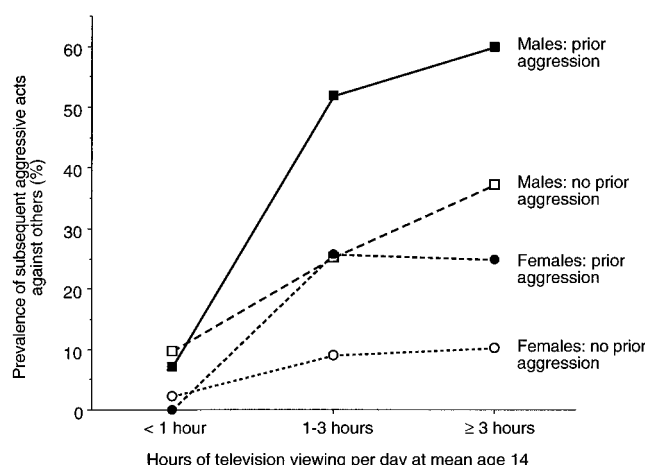
In the male subsample, television viewing at mean age 22 was associated with subsequent assaults or fights resulting in injury. In the female subsample, television viewing at mean age 22 was associated with subsequent assaults or fights resulting in injury, robbery, threats to injure someone, or use of a weapon to commit a crime, and any aggressive act against another per-

son. The association between television viewing at mean age 22 and any aggressive act against another person was significantly stronger in the female subsample than in the male subsample ( $z = 2.44$ ;  $P = 0.01$ ).

Aggressive behaviors at mean age 14 were not associated with subsequent television viewing after the covariates were controlled statistically. However, youths who committed assaults or participated in fights resulting in injury at mean age 16 spent significantly more time watching television at mean age 22 than did the remainder of the youths in the sample ( $\chi^2 = 10.94$ ;  $df = 2$ ;  $P = 0.004$ ). This association remained significant after the covariates were controlled.

The present findings indicate that extensive television viewing by adolescents and young adults is associated with an increased likelihood of committing aggressive acts against others. Our findings suggest that this association is only partially attributable to environmental characteristics that are associated with both television viewing and aggressive behavior. These findings are also consistent with the hypothesis that extensive television viewing partially mediates, or helps to explain the association between certain environmental risks and subsequent aggressive behavior (30). It should be noted that a strong inference of causality cannot be made without conducting controlled experiment, and we cannot rule out the possibility that some other covariates that were not controlled in the present study may have been responsible for these associations. Epidemiological studies, such as the present study, are conducted when it is not permissible to conduct a controlled experiment due to the adverse outcomes that may result from prolonged exposure to a potentially harmful stimulus.

**Fig. 1.** Association between time spent watching television at mean age 14 by males and females with and without a history of aggressive behavior, and the prevalence of aggressive acts against others, reported at mean age 16 or 22.



**Table 2.** Television viewing at mean age 22 and aggressive acts reported at mean age 30 ( $n = 707$ ).

Aggressive acts reported at mean age 30	Study group (n)	Television viewing at mean age 22 (hours/day)			Adjusted odds ratio (95% CI)‡
		< 1% (n)	1 to 3% (n)	≥3% (n)	
Assault or physical fights resulting in injury	Total sample (707)	1.2% (1 of 83)	2.7% (23 of 411)	10.8% (35 of 213)*	2.62 (1.58–4.33)†
	Males (360)	2.4% (1 of 41)	3.9% (8 of 207)	13.4% (15 of 112)*	1.79 (0.77–4.13)
	Females (347)	0% (0 of 42)	1.5% (3 of 204)	7.9% (8 of 101)*	4.21 (1.02–17.29)†
Robbery, threats to injure someone, or weapon used to commit a crime	Total sample	6.0% (5 of 83)	7.8% (32 of 411)	10.8% (23 of 213)	1.26 (0.80–1.99)
	Males	12.2% (5 of 41)	11.6% (24 of 207)	9.8% (11 of 112)	0.80 (0.45–1.40)
	Females	0% (0 of 42)	3.9% (8 of 204)	11.9% (12 of 101)*	3.24 (1.23–8.57)†
Any aggressive act against another person	Total sample	7.2% (6 of 83)	9.0% (37 of 411)	17.8% (38 of 213)*	1.57 (1.04–2.38)†
	Males	14.6% (6 of 41)	14.0% (29 of 207)	18.8% (21 of 112)	1.00 (0.61–1.65)
	Females	0% (0 of 42)	3.9% (8 of 204)	16.8% (17 of 101)*	4.73 (1.83–12.35)†

\*Significantly higher level of subsequent aggression in comparison with individuals who spent less time watching television at mean age 14. †Significant association after controlling for the covariates that were significantly associated with television viewing and subsequent aggression. NOTE: Odds ratios indicate the average increase in the odds for subsequent aggression associated with an increase in the level of television viewing (e.g., from <1 hour to 1 to 3 hours per day of television viewing). ‡95% confidence interval.

## REPORTS

What may account for the gender differences in timing of the effects of extensive television viewing? One possibility, which remains to be explored, is a difference in the content of programs watched by males and females during adolescence and early adulthood. However, violent acts are depicted frequently on television, and previous research has supported the hypothesis that televised violence accounts, in large measure, for the association between television viewing and aggression (31).

Our finding that one index of adolescent aggression was associated with subsequent television viewing after the covariates were controlled is consistent with the hypothesis that there is a bidirectional relationship between television violence and aggressive behavior. However, time spent watching television was associated with subsequent aggression, whether or not there was a history of aggressive behavior (Fig. 1). Thus, although aggressive individuals may spend somewhat more time watching television than do other individuals, this tendency does not appear to explain the preponderance of the association between television viewing and aggressive behavior.

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- Analyses of contingency tables were conducted to investigate associations between television viewing and subsequent aggression, and to investigate associations between the covariates, television viewing, and aggression. Log-linear logistic regression analyses were conducted to investigate whether television viewing was associated with risk for subsequent aggressive behavior after controlling for the covariates that were associated with both television viewing and aggressive behavior: childhood neglect; low family income; low parental education; growing up in a dangerous neighborhood; psychiatric disorders; and previously reported aggressive behavior. These odds ratios indicate the average increase in the odds for subsequent aggression associated with an increase in the level of television viewing (e.g., from <1 hour to 1 to 3 hours per day of television viewing). There were no statistically significant quadratic associations between these variables. The analyses were based on the assumption that the three levels of television viewing were equally spaced.
- Because the associations between adolescent television viewing and subsequent aggressive behavior were similar in the male and female subsamples (Fig. 1), the nonsignificant association among the females may be attributable to the sparsity of aggressive behavior among the females.
- The association between the amount of time spent watching television at mean ages 14 and 22 was significant after the age of the participant was controlled statistically.
- The statistical conditions required for this mediational hypothesis were met in the present study when television viewing remained significantly associated with subsequent aggression after the covariates that were associated with television viewing and aggressive behavior were controlled [see D. A. Kenny, D. A. Kashy, N. Bolger, in *Handbook of Social Psychology*, D. Gilbert, S. T. Fiske, G. Lindzey, Eds. (McGraw-Hill, New York, NY, 1997), pp. 233–265].
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