Mediational Analysis of the LdP intervention

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The LdP trial

Tumori, 99: 586-591, 2013

A school-based peer-led smoking prevention intervention with extracurricular activities: the LILT-LdP cluster randomized controlled trial design and study population

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Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Effectiveness of a school-based multi-component smoking prevention intervention: The LdP cluster randomized controlled trial

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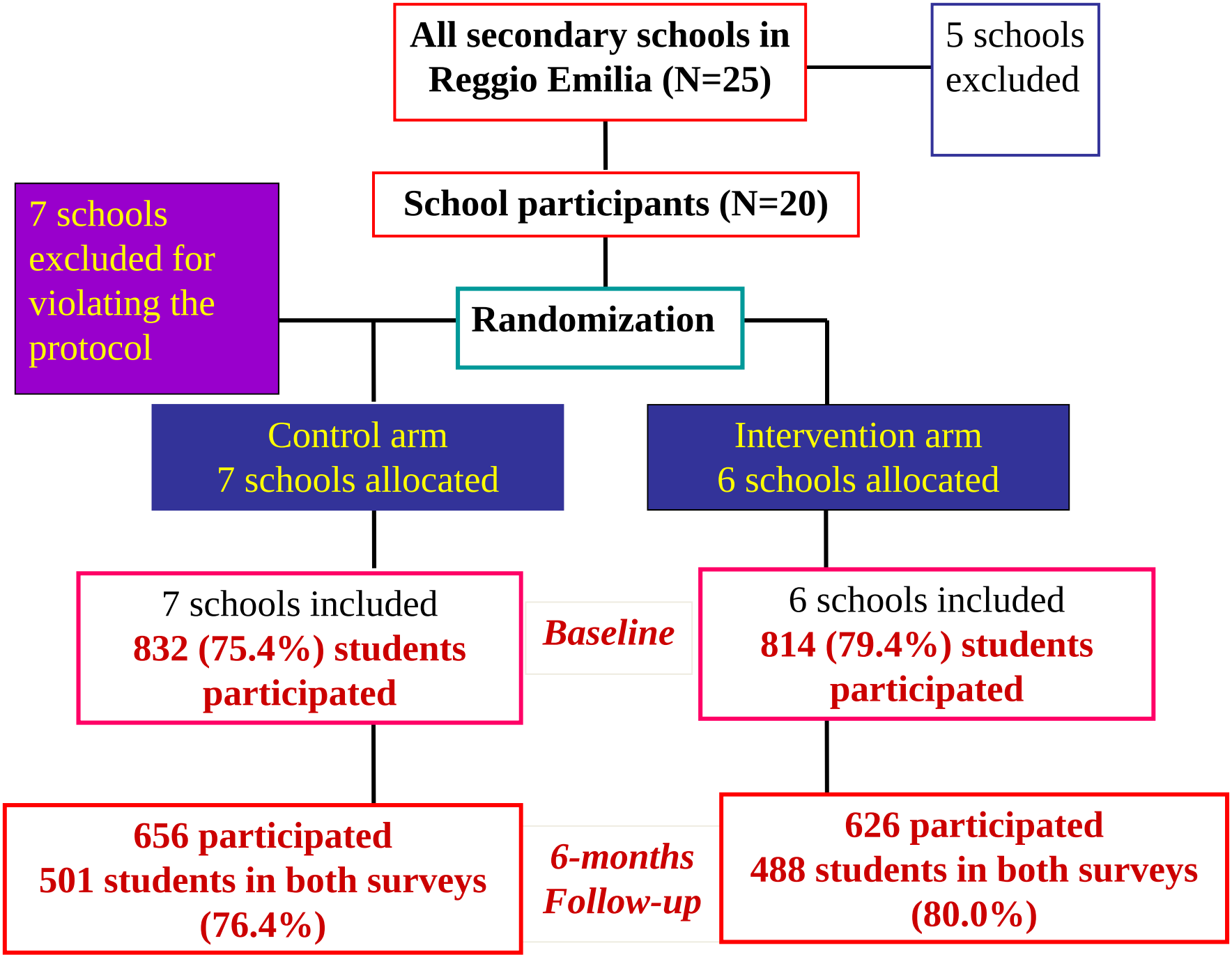
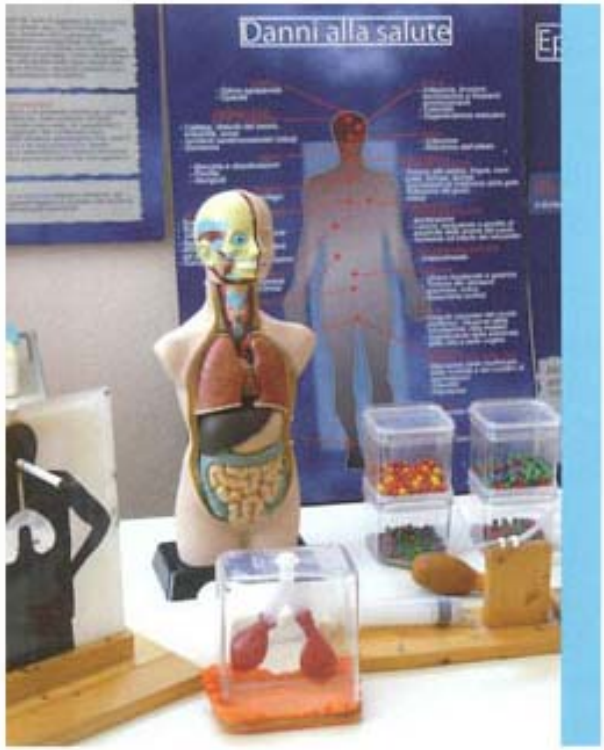

All secondary schools in Reggio Emilia (N=25)
5 schools excluded
School participants (N=20)
7 schools excluded for violating the protocol
Randomization
Control arm
7 schools allocated
Intervention arm
6 schools allocated
7 schools included
832 (75.4%) students participated
Baseline
6 schools included
814 (79.4%) students participated
656 participated
501 students in both surveys
(76.4%)
6-months Follow-up
626 participated
488 students in both surveys
(80.0%)

LdP intervention in the experimental arm

Four parts:

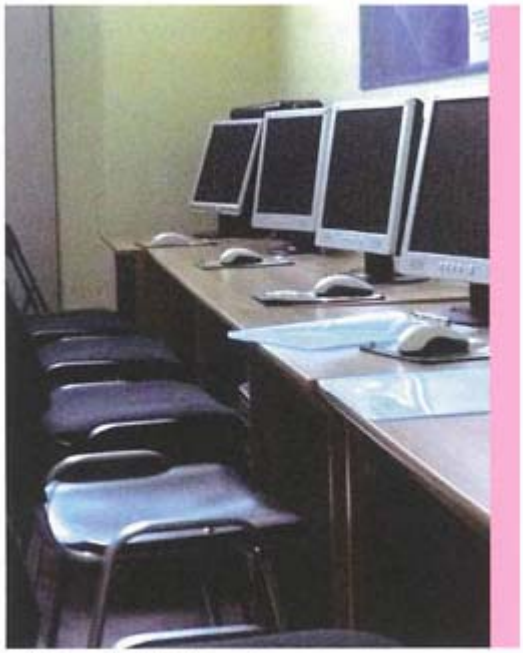
- the “Smoking Prevention Tour” (SPT) workshops at the “Luoghi di Prevenzione” Center, four 40-minute sessions
- one in-depth lesson on one SPT topic
- a life-skills peer-led intervention (two 2-hour meetings per class)
- School anti-smoking policy: compliance control & revision

The “Smoking Prevention Tour” workshop



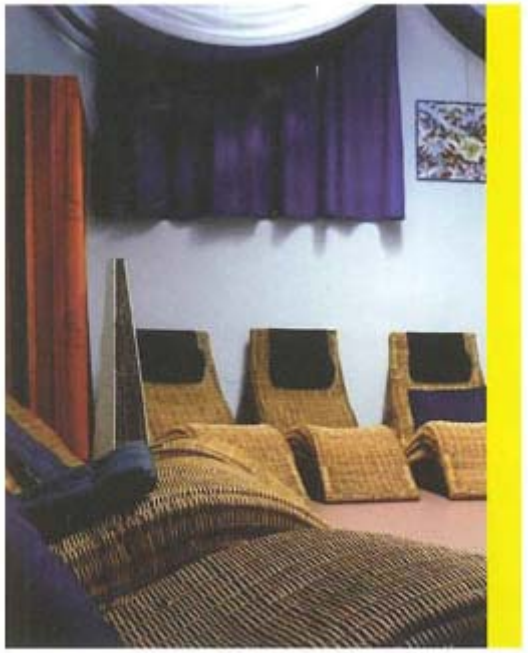
Laboratorio scientifico fumo di sigaretta

Lab session



Laboratorio informatico

Computer session



Laboratorio analisi immaginativa

Imaginative & creative writing sessions

Outcomes

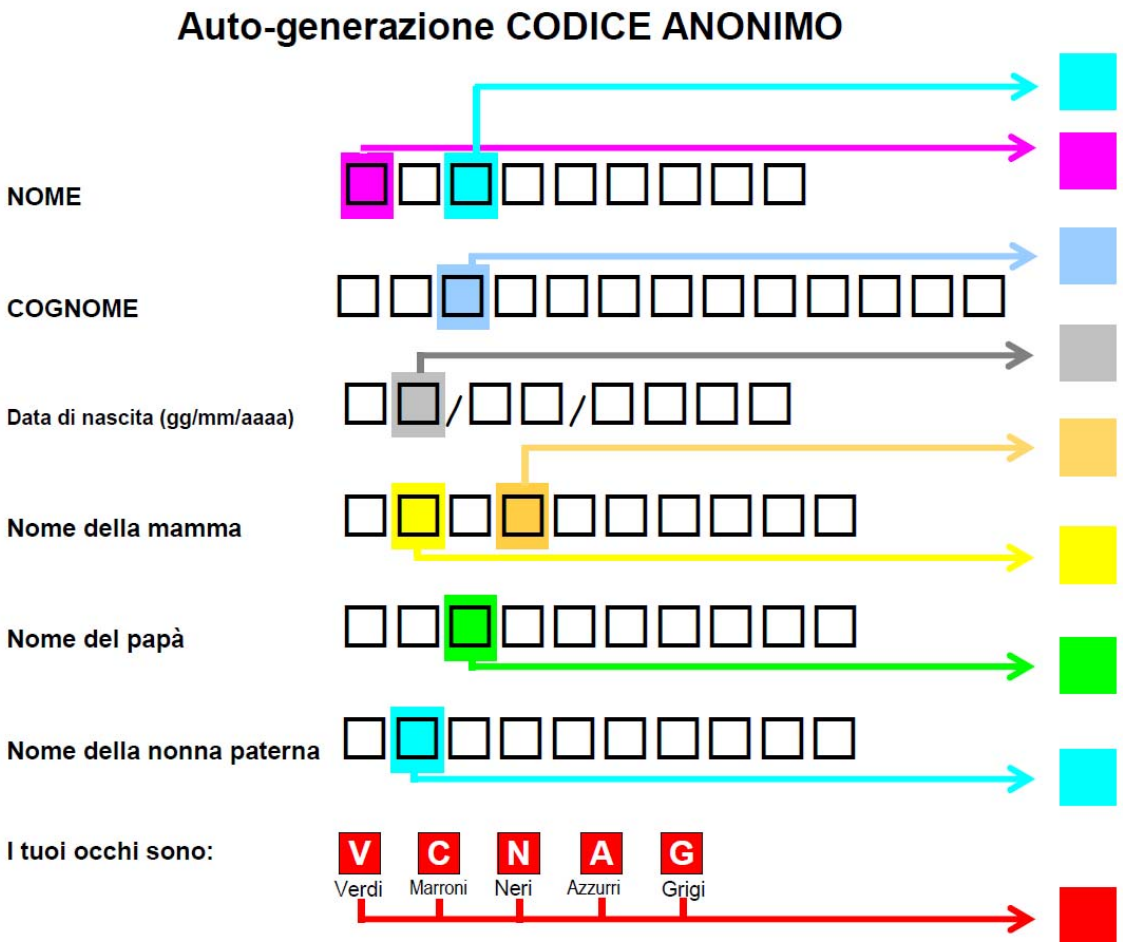
- Self-reported past 30-day smoking of ≥20 or 1–19 days of cigarette smoking (daily or frequent smoking, respectively)

- Smoking at school

recorded in 2 surveys administered before and 18 months after the beginning of the programme

Anonymous questionnaire

32 items



Monitoring of the programme process

Programme parts	Schools (%)	Students (%)
Peer Education	6 (100.0)	471 (96.5)
SPT workshops	6 (100.0)	461 (94.5)
Class lesson on one SPT workshops	4 (66.7)	385 (78.9)
At least one training lesson on SPT Workshops for teachers	6 (100.0)	--
School Tobacco Policy: control of smoking signs and enforcement surveillance; formation of a school working-group; revision of school smoking regulation	6 (100.0)	488 (100.0)
School Tobacco Policy: introduction of the revised smoking policy	2 (33.3)	184 (37.7)

Statistical analyses

- A propensity score analysis was performed. The covariates used for the propensity-matching analysis were independent from the intervention: age, gender, parents' education and origin, school type, and smoking status at baseline

- Two groups with comparable baseline information after matching were produced.
- The effect of the intervention was then estimated by fitting a logistic model applied to the propensity score-matched database by allowing for intra-school correlation and including the unbalanced intervention-dependent variables (date of the baseline survey and days between baseline and followup surveys) as covariates

- Analysis was done by intention to treat, with missing values on the outcome variables replaced by a value indicating current smoking

Results – all students

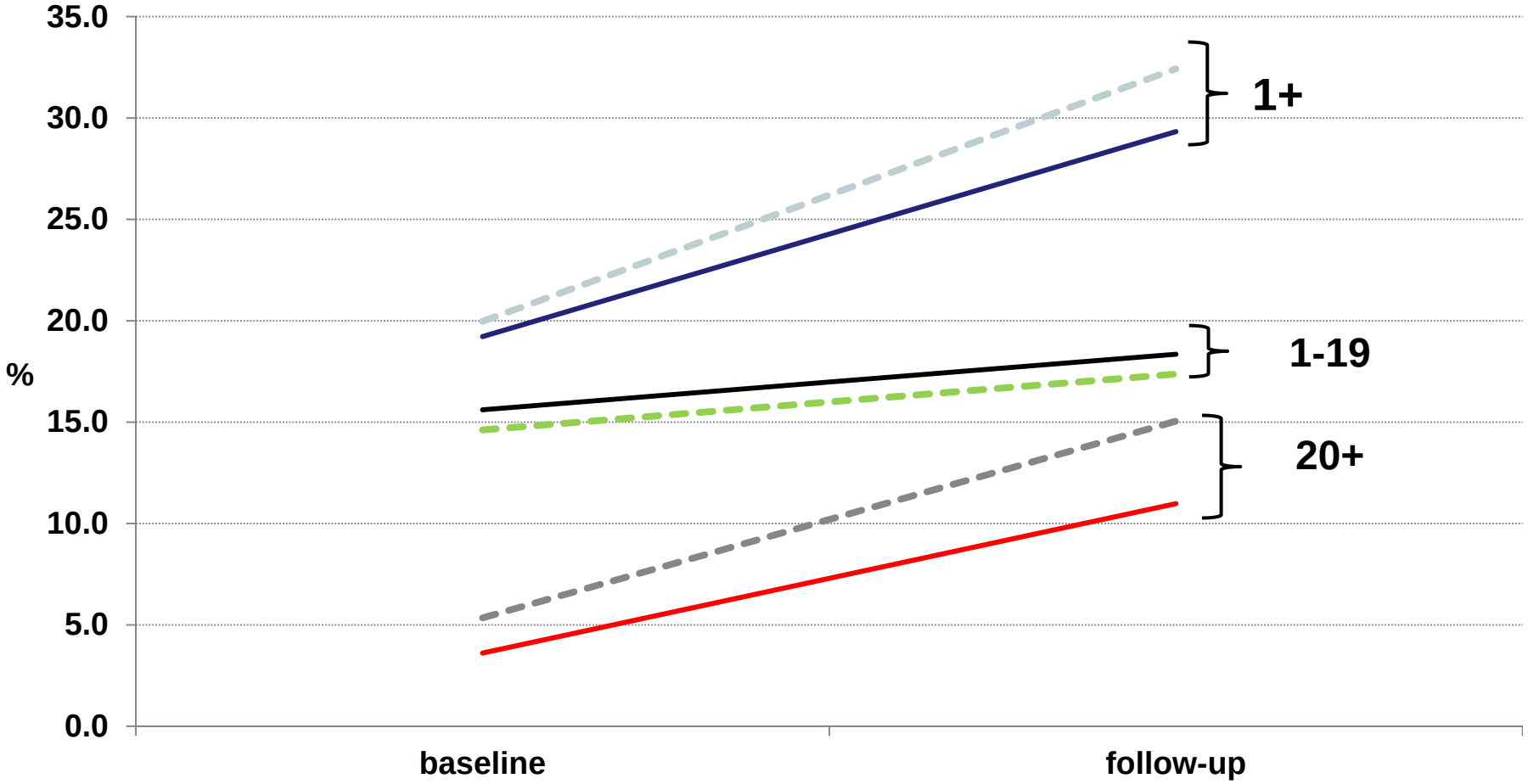
Students in the experimental arm recorded:

- a significant 31% reduction in reporting having smoked in the last 30 days at follow-up
- a significant 46% reduction in reporting daily smoking (20+) in comparison to controls

A "delay" effect in the progression towards daily smoking

	Control N=501 7 schools	Intervention N=488 6 schools	Matched on propensity score OR (95% CI)
Past 30-day smoking (1+) at fu	169	147	**0.69 (0.50-0.95)**
Daily smoking (20+) at fu	79	53	**0.54 (0.40-0.72)**
Frequent smoking (1-19) at fu	90	94	0.85 (0.63-1.14)

Results –all students



Results – non-smokers at baseline

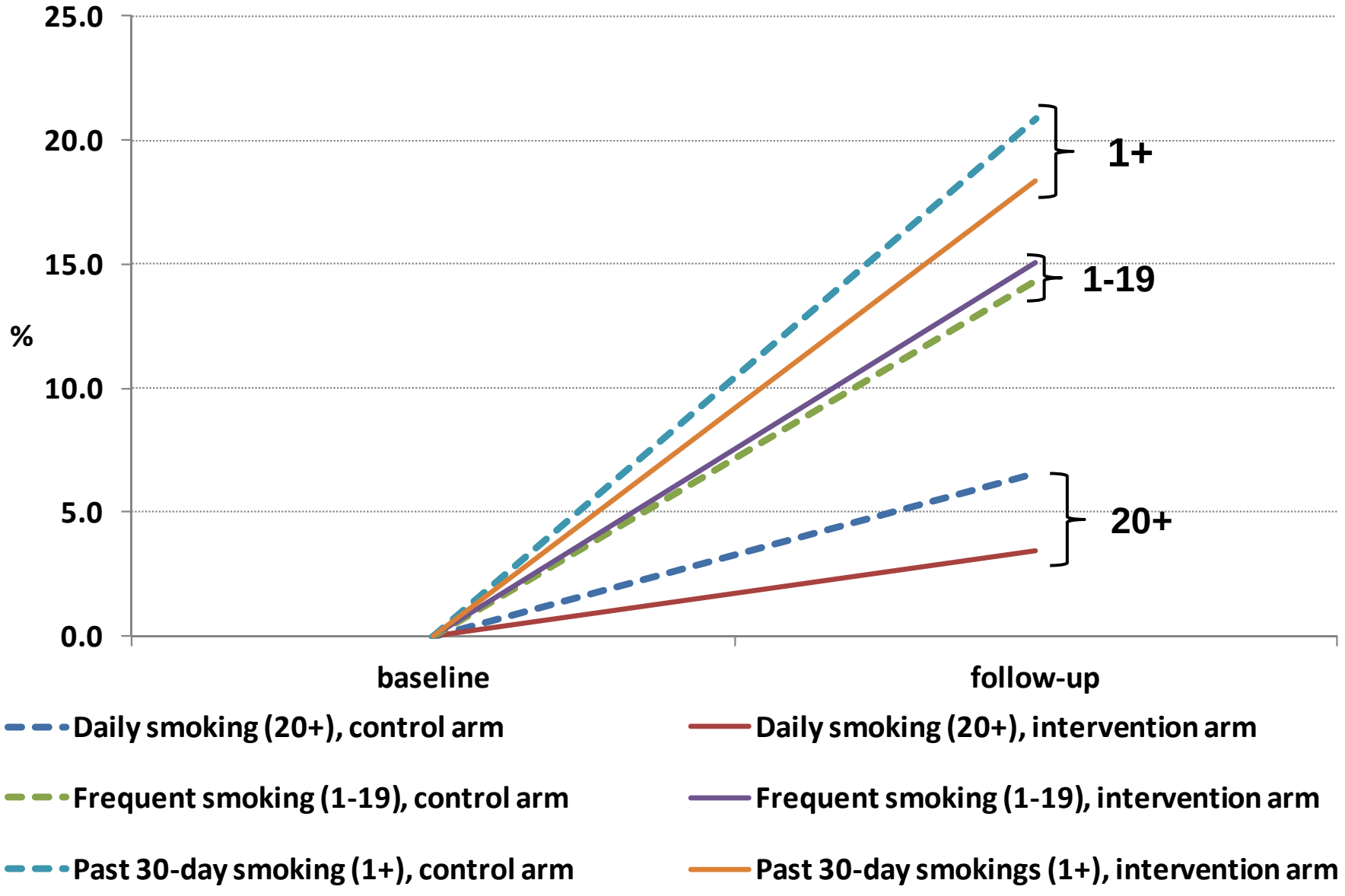
Students in the exp arm showed:

- a significant 59% reduction in reporting daily consumption

This "delay" effect especially worked in non-smokers at the baseline

Non-smoking at baseline	Control N=392 7 schools	Intervention N=403 6 schools	Matched on propensity score OR (95% CI)
Past 30-day smoking (1+) at fu	84	80	0.67 (0.42-1.06)
Daily smoking (20+) at fu	26	15	**0.41 (0.24-0.69)**
Frequent smoking (1-19) at fu	58	65	0.79 (0.49-1.28)
Non-smoking at fu	308	323	1.49 (0.94-2.36)

Non-smokers at baseline



Results – smoking in school areas

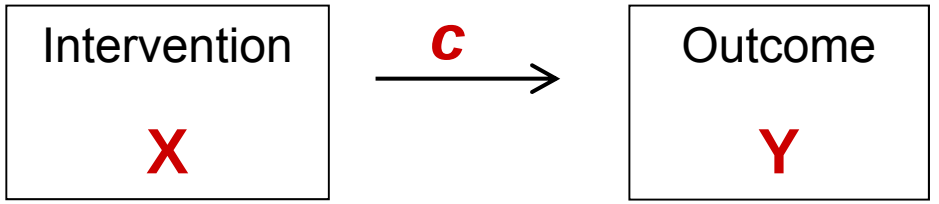
Smoking students showed a significant reduction of 62% in smoking in school areas (playgrounds, aisles, toilets) at follow-up, in comparison to controls

Revising and enforcing a school smoking policy worked

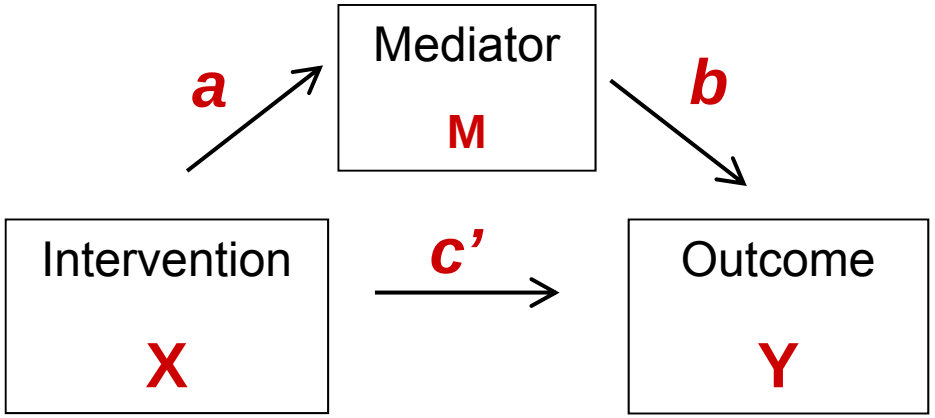
	Control N=501 7schools	Intervention N=488 6 schools	Matched on propensity score OR (95% CI)
Past 30-day smoking (1+) at fu	169	147	**0.38 (0.16-0.90)**
Daily smoking (20+) at fu	79	53	1.01 (0.20-4.87)
Frequent smoking (1-19) at fu	90	94	**0.22 (0.07-0.71)**

Mediation & effectiveness analyses

Effectiveness analysis of the Cluster RCT



Mediational analysis



a: how the programme modifies mediators

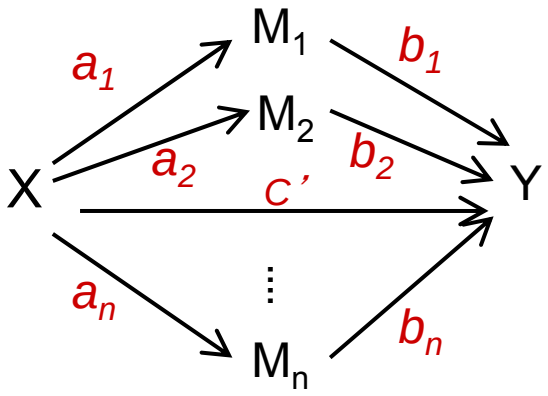
b: how mediators are associated to the outcome

direct effect *c'* : X effect on Y, adjusting for M

mediated/indirect effect *ab*: X effect on *Y* through M

total effect c=c'+ab : direct effect + mediated effect

Multiple mediation



Indirect effect specific of each M_i: $a_i b_{itot}$
Overall mediated effect : $\sum_i a_i b_i$
Overall effect $c = c' + \sum_i a_i b_i$

- Analysis is similar to a multiple regression
- We estimated the effect of each mediator, adjusting for the others

Statistical analysis

- We carried out a multilevel multiple mediation analysis entering all mediators simultaneously.
- Randomization occurred at the school level, so we entered school as the second level, and individuals as the first level and we implemented a $2 \rightarrow 1 \rightarrow 1$ multilevel model, where the intervention is designed to change mediators in order to reduce outcomes.
- We took into account missing data, performing a multiple imputation procedure, the Multivariate Imputation by Chained Equations (MICE)

[Zhang et al, 2009, Preacher and Hayes, 2008, Krull and MacKinnon, 2001, Whang et al, 2014; Zhang and Whang, 2013, Raghunathan et al, 2001]

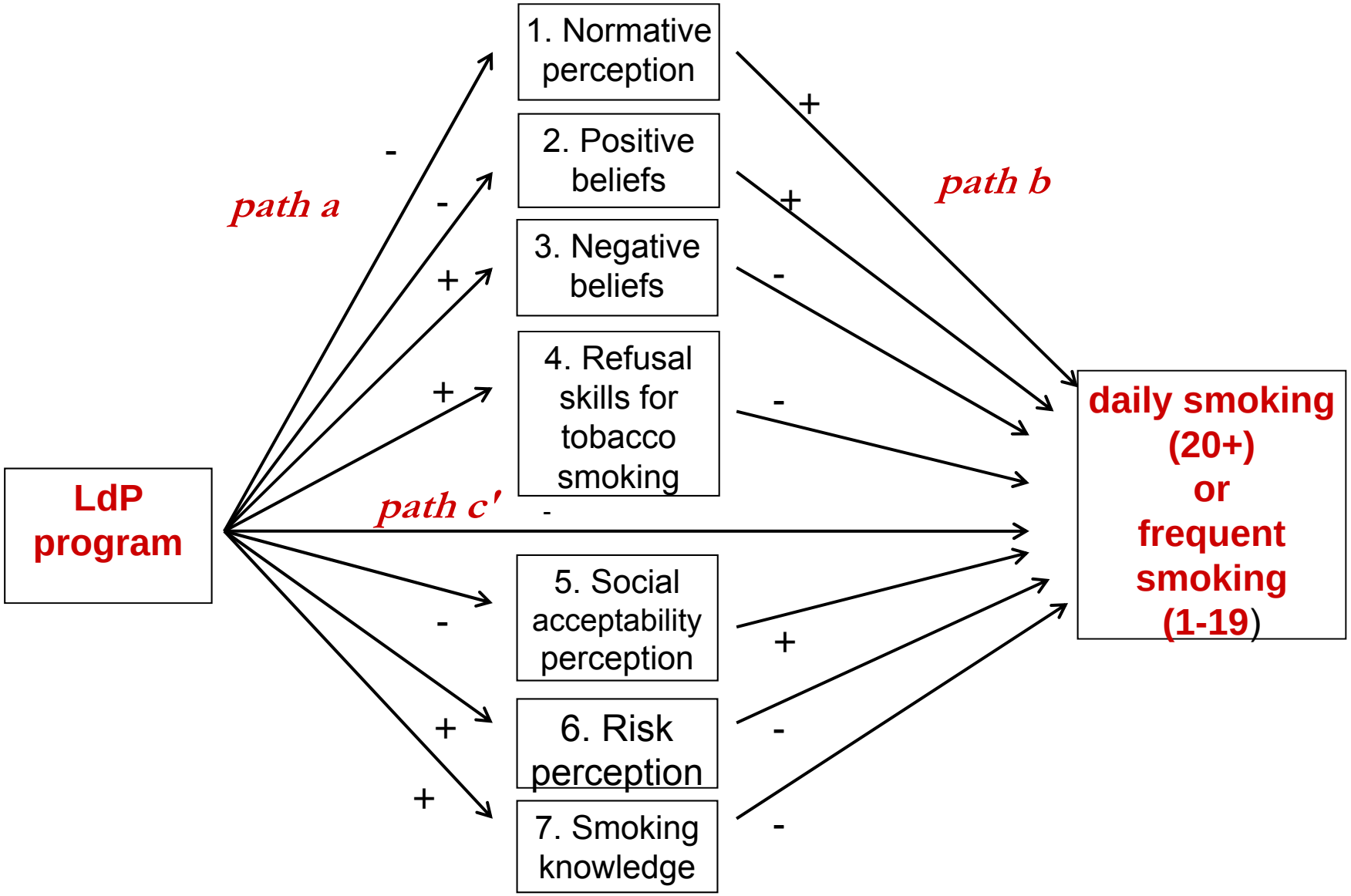
Definition of mediators - 1

Mediator	Question and items	Definition
1. Normative perception	In your opinion, how many students are current smokers?	0: 10%-25% 1: 50%-75%-all
2. Positive beliefs	If you will smoke in the next month, do you think that you will -Feel more relaxed -Have more fun -Be more popular -Feel more friendly and approachable	0: no positive beliefs 1: at least one positive belief
3. Negative beliefs	If you will smoke in the next month you think you will become addicted?	0: no negative belief 1: at least one negative belief
4. Refusal skills for tobacco smoking	If one of your best friends offered you a cigarette, would you smoke?	0: no ability to refuse 1: ability to refuse

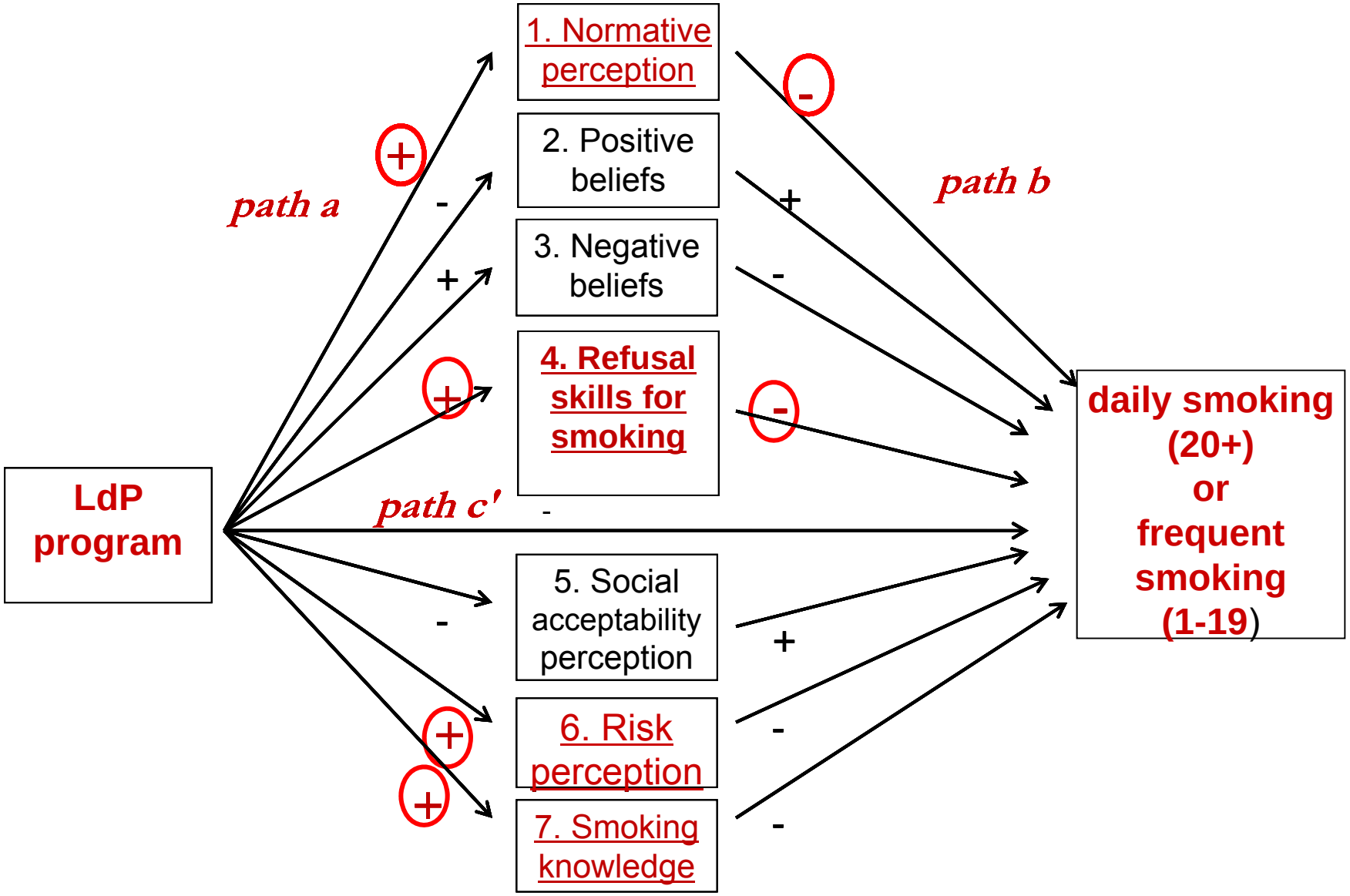
Definition of mediators - 2

Mediators	Question and items	Definition
5. Social acceptability perception	Do you agree with the following statements? -Youths who smoke have more friends -Smoking makes youths cooler -Not smoking is a way of expressing my independence	0: smoking socially not accepted 1: smoking socially accepted or accepted on average
6. Risk perception	-How much do you think are likely to be damaged (physically or otherwise), people who smoke cigarettes occasionally	0: misperception 1: right perception
7. Smoking knowledge	Do you agree with the following statements? -Nicotine is the substance that causes lung cancer -You need to smoke a lot of cigarettes a day to become addicted	0: no/little knowledge 1: correct knoledge
8. Awareness about dangers of second-hand smoke	Breathing other people's smoke is bad for your health	0: does not agree 1: agree

Mediation hypothesis



Mediation results



Results - 1

- **Refusal skills** – LdP programme determined a significant increase in refusal skills (path a), and this determined a significant reduction in smokers (path b). The total indirect effect (ab) is strong (coeff=-1.98) in the hypothesized direction

- **Normative perception** **-** LdP determined a significant increase in normative perception (path a) and this determined a significant reduction in smokers (path b). The indirect effect is significant and in the hypothesized direction (smokers' reduction); coeff=-0.15

Results - 2

- **Risk perception** – LdP determines a significant increase in risk perception (path a), but this did not cause any smokers' reduction (path b), and the total indirect effect is not significant

- **Smoking knowledge –** LdP determines a significant increase of knowledge (path a), but this did not cause any smokers' reduction (path b), and the total indirect effect (ab) is not significant

Results - All students, outcome: daily smoking (>20 sig in 30 days)

Total indirect effect $\sum_i a_i b_i$ = -1.00 (-6.73,2.42)
Direct effect c' = 0.13 (-1.23,0.40)

	a			b			ab		
MEDIATORS	**coeff**	**95% CI**		**coeff**	**95% CI**		**coeff**	**95% CI**	
1. Normative perception	**0.38**	**0.04**	**0.80**	**-1.02**	**-1.65**	**-0.47**	**-0.38**	**-1.02**	**-0.04**
2. Positive beliefs towards smoking	-0.08	-0.54	0.21	-0.15	-0.33	1.09	0.01	-0.31	0.13
3. Negative beliefs towards smoking	0.62	-0.14	0.64	**1.27**	**0.04**	**0.80**	0.79	-0.24	1.15
4. Refusal skills towards smoking	**0.41**	**0.11**	**1.00**	**-3.50**	**-5.63**	**-3.09**	**-1.44**	**-4.23**	**-0.42**
5. Perception of social acceptability	-0.19	-0.60	0.19	-0.80	-1.29	0.01	0.15	-0.12	0.49
6. Risk perception	**0.48**	**0.26**	**1.00**	-0.07	-0.90	0.30	-0.03	-0.68	0.19
7. Knowledge towards smoking	**0.59**	**0.01**	**1.10**	-0.19	-0.22	1.23	-0.10	-0.13	0.92

Results - All students, outcome: current smokers (>1 sig in 30 days)

Effetto totale indiretto $\sum_i a_i b_i$ = -1.80 (-5.47,0.79)

Effetto diretto c’ = -0.64 (-0.47,0.78)

	a			b			ab		
MEDIATORS	**coeff**	**95% CI**		**coeff**	**95% CI**		**coeff**	**95% CI**	
1. Normative perception	**0.37**	**0.04**	**0.86**	**-0.41**	**-1.30**	**-0.37**	**-0.15**	**-0.80**	**-0.03**
2. Positive beliefs towards smoking	-0.03	-0.54	0.18	0.04	-0.27	0.79	0.00	-0.26	0.09
3. Negative beliefs towards smoking	0.76	-0.10	0.66	0.20	-0.67	0.31	0.15	-0.25	0.10
4. Refusal skills towards smoking	**0.53**	**0.11**	**0.94**	**-3.72**	**-4.10**	**-3.10**	**-1.98**	**-3.38**	**-0.37**
5. Perception of social acceptability	-0.08	-0.58	0.18	0.22	-0.77	0.19	-0.02	-0.08	0.29
6. Risk perception	**0.50**	**0.26**	**0.99**	-0.05	-0.87	0.08	-0.02	-0.61	0.05
7. Knowledge towards smoking	**0.32**	**0.00**	**1.09**	0.71	-0.17	0.91	0.23	-0.10	0.68

Results – Non smokers at baseline, outcome: daily smokers (>=20 sig in 30 days)

Effetto totale indiretto $\sum_i a_i b_i$ = -0.62 (-1.33,0.57)

Effetto diretto c' = -0.82 (-2.10,0.47)

	a			b			ab		
MEDIATORS	**coeff**	**95% IC**		**coeff**	**95% IC**		**coeff**	**95% IC**	
1. Normative perception	**0.06**	**0.00**	**0.17**	**-0.31**	**-2.06**	**-0.23**	**-0.02**	**-0.21**	**0.00**
2. Positive beliefs towards smoking	-0.05	-0.14	0.04	0.78	-0.26	1.74	-0.04	-0.16	0.03
3. Negative beliefs towards smoking	0.02	-0.03	0.12	**1.10**	**0.13**	**2.11**	0.03	-0.04	0.17
4. Refusal skills towards smoking	**0.12**	**0.00**	**0.16**	**-4.23**	**-4.70**	**-2.37**	**-0.50**	**-0.59**	**0.00**
5. Perception of social acceptability	-0.12	-0.14	0.03	-0.31	-1.15	0.60	0.04	-0.04	0.10
6. Risk perception	**0.13**	**0.05**	**0.23**	-1.17	-1.78	0.27	-0.15	-0.28	0.04
7. Knowledge towards smoking	**0.02**	**0.00**	**0.14**	**0.89**	**0.12**	**2.22**	**0.02**	**0.00**	**0.23**

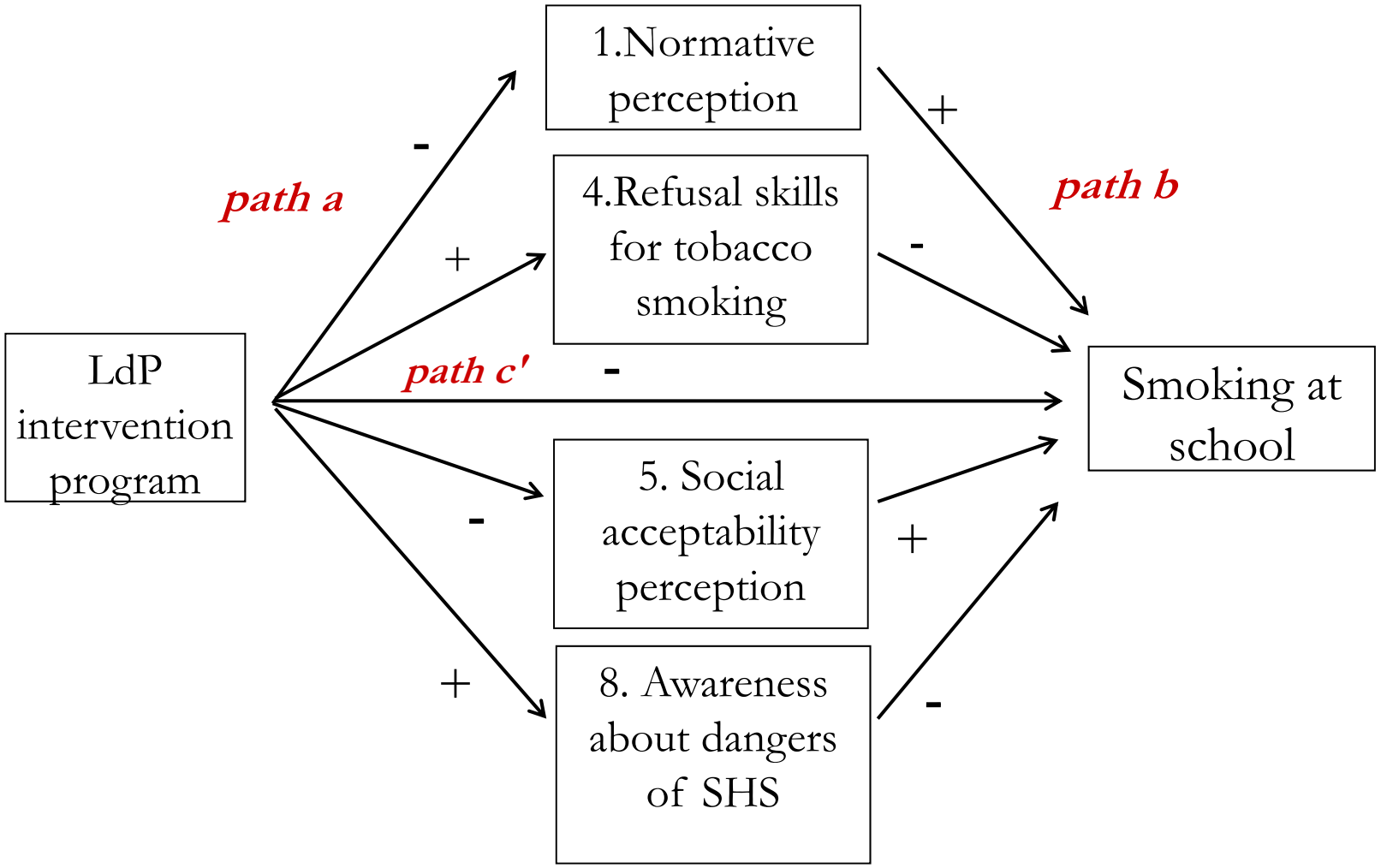
Results - Non smokers at baseline, outcome: current smokers (>1 sig in 30 days)

Effetto totale indiretto $\sum_i a_i b_i$ = -0.59 (-1.12,0.23)

Effetto diretto c' = 0.40 (-0.64,0.76)

	a			b			ab		
MEDIATORS	**coeff**	**95% IC**		**coeff**	**95% IC**		**coeff**	**95% IC**	
1. Normative perception	**0.02**	**0.00**	**0.16**	**-1.08**	**-1.62**	**-0.52**	**-0.02**	**-0.21**	**0.00**
2. Positive beliefs towards smoking	-0.05	-0.14	0.03	0.05	-0.27	0.89	0.00	-0.08	0.02
3. Negative beliefs towards smoking	0.08	-0.04	0.12	-0.37	-1.01	0.09	-0.03	-0.08	0.02
4. Refusal skills towards smoking	**0.12**	**0.00**	**0.15**	**-3.40**	**-4.21**	**-3.15**	**-0.39**	**-0.55**	**0.00**
5. Perception of social acceptability	-0.02	-0.14	0.03	-0.25	-0.98	0.14	0.01	-0.02	0.10
6. Risk perception	**0.26**	**0.05**	**0.23**	-0.62	-0.93	0.09	-0.16	-0.16	0.01
7. Knowledge towards smoking	**0.08**	**0.01**	**0.13**	0.08	-0.54	0.73	0.01	-0.04	0.06

Outcome “smoking at school”



Results

- Ldp programme showed a significant effect in reducing smoking in school areas, adjusting for mediators (direct effect c’)
- Ldp programme did not show any effect through mediators (path a)

Promoting and enforcing an anti-smoking school policy may act directly reducing the habit of smoking in school areas, or through other mediators we did not consider

Results – current smokers (>1 sig in 30 days)

Overall indirect effect $\sum_i a_i b_i$ = 0.11 (-5.27,2.84)

Direct effect **c' = -1.42 (-2.38,-0.69)**

	a			b			ab		
MEDIATORI	**coeff**	**95% CI**		**coeff**	**95% CI**		**coeff**	**95% CI**	
1. Normative perception	-0.31	-0.48	0.94	**-0.59**	**-1.43**	**-0.19**	0.18	-0.86	0.41
4. Refusal skills	0.09	-0.67	1.33	**-2.31**	**-3.39**	**-1.45**	-0.22	-3.02	1.55
5. Perception of social acceptability	-0.09	-0.57	1.00	**-0.89**	**-1.37**	**-0.02**	0.08	-0.87	0.49
9. Awareness on SHS effects	0.17	-0.86	0.59	0.42	-0.45	1.14	0.07	-0.52	0.39

Conclusions

- LdP programme was effective in delaying the progression towards daily smoking, in particular among non-smokers at baseline
- The LdP intervention reduced cigarette smoking through two mediators: refusal skills for smoking & normative perception.
- The association between the intervention and normative perception however acted in the direction opposite to the expected.
- The programme showed to act significantly increasing risk perception and smoking knowledge, but these mediators had no effect on smoking reduction.
- LdP intervention directly acted on reducing smoking in school areas.


Grazie

The “Smoking Prevention Tour” (SPT) workshops at the LILT "Luoghi di Prevenzione" Centre - 1

SPT consists of 4-hour extracurricular activities divided into four 40-minute sessions:

a) **Creative writing**: smoking signs (smoking and emotions, thoughts, experiences, key-words), personal feeling of smoking (feelings, beliefs, experiences)

b) **Lab experiments**: PM measurement, lab trials for separating different smoking substances policy

The “Smoking Prevention Tour” (SPT) workshops at the LILT "Luoghi di Prevenzione" Centre - 2

c) **Computer session**: on physical and psychological wellness and on stress levels; for non-smokers: test on curiosity level about smoking; for smokers: the Fagerstrom Tolerance Questionnaire, test on motivation to quit; for former smokers: test on motivation to be a sustained non-smokers

d) **Imaginative session**: the educator read a novel on the experience of smoking a cigarette during a Saturday night in a disco-club. Students had to identify themselves with the character. This experience was compared with a non-smoker experience.