





- %LRO 7RGD\ V :RUOG

6HDO WKH WXEHV DQG LQFXEDWRP &MKHPTXIRUH WHVM ZDV XVHGUMRDEBFR  
WPHSHUDWJUH TXDOLWDWLYH YDULDEOHV

\$VSLUDWH WKH VXSHUQDWDQW IUR\$ QDOFKLWXEIHYPJLHSDQFDIRWKHWHKH WRRHVRD  
FRXQW:WVXHWKH WXEHV WKUHH WLPHVZLQWRKPLDPO SDUGLPHXWHUGDV UHJDU  
ZDVK VROXWLRQ \$IWHU HDFK DGGLWLRQ RLD GLOXWHG ZDVK VROXWLRQ  
DVSLUDWH DOO RI WKH ZDVK VROXWLRQ

&RXQW HDFK WXEH IRU DW FRXQW S YDOXH! LQVLJQLILFDQW  
FDOLEUDWHG>W@ GHWHFW S VLJQLILFDQW

%LDV

: H WULHG WR DYRLG ELDV ZLWKLQXEDWRP 5 (68)78 WLYH GDWD DQDO\VLV EI  
PXOWLSOH SHRSOH WR FRGHLWQSHGDWD DQG ZH UHYLHZHG  
ZLWK SHHUV 3DUWLFLSDQWV

6WXG\ VLJH

,Q RXWXG\ SDWLHQWV RQ GHLDOWKLV DQG  
LQGLYLGXDOV ZHUH LQFOXGHG WKH\ ZHUH FODVVLILHG LQWR  
JURXS

\*URXS,QFOXGHV SDWLHQSDU DRQKGLDQGVLY WKHLU SDWLHQSDU DRQKGLDQGVLY  
KRUPRQH OHYHO SJ PO \*URXS,QFOXGHV SDWLHQSDU DRQKGLDQGVLY

\*URXS,QFOXGHV SDWLHQSDU DRQKGLDQGVLY WKHLU SDWLHQSDU DRQKGLDQGVLY  
KRUPRQH OHYHO! SJ PO \*URXS,QFOXGHV KHDOWKFRQVUR

\*URXS ,QFOXGHV KHDOWKFRQVURIGXDOV DV D  
JURXS 'HVFULSWLYH GDWD

4XDQWLWDWLYH YDULDEOHV

7KH\ ZHUH PDOHV DQG IHPDOHV L  
'HVFULSWLRQ RI TXDQWLWDWLYH YDULDEOHV DQG 6' IHPDOHV LQ F  
'HVFULSWLRQ RI TXDOLWDWLYH YDULDEOHV DV QXPEHU DQG SHUFHQW DJ

6WDWLWVWLFDO PHWKRGV

7KHLU PHDQ DJH ZDV \HDUV IRU  
\$QDO\VLV RI GDWD ZDV GRQH EI ,%0 \HDUV IRU JURXS , DQG \HDUV I  
,QGHSHQGHW VDP SOH W WNDQWZLWDWLYH WR FRPSDUH  
YDULDEOHV LQ SDUDPHWULF GDWD 6' PHDQ

7DEOHHPRJUDSKLF FKDUDFWHULVWLFV RI SDWLHQWV RQ GLDO\VLV ZLWK 37+  
JURXS JURXS LLL

	*URXS ,	*URXS ,,	*URXS ,,,	S YDOXH		
	37+	37+!	&RQWURO			
	1	1	1			
\$JH						
UDQJ 0 " 6'	"	"	"	, YV ,,	, YV ,,,	, YV ,,,
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ODOH				, YV ,,	, YV ,,,	, YV ,,,
)HPDOH						

7KH PHDQ %0, RI JURXS , ZDV " ZKLOH " IRU JURXS ,, ZLWK D KLJKO\ VLJQLILFDQW VWDWLWVWLFDO GLIIHUHQFH  
S 7DEOH



UDQJ 0 " 6'	"	"	"	, YV ,,	, YV ,,,	,, YV ,,,
3K UDQJ 0 " 6'	"	"	"	, YV,,	, YV ,,,	,, YV ,,,

**0DLQ UHVXOWV**

FKROHVWHURO OHYHO ZKLFK ZDV  
 7KHU KLJKO\ VLJQLILFDQW VWDWLWLVFDQW GLIIHUHQFH ERQWURO JURXS  
 WULJO\FHULGH OHYHO RI ERWK JURXS ERQWURO ERQWURO JURXS  
 RI WULJO\FHULGH ZDV " IRU SDWLWLVFDQW VLJQLILFDQW VWDWLWLVFDQW  
 " LQ FRQWURO JURXS DQG IRU SDWLWLVFDQW VLJQLILFDQW GLIIHUHQFH  
 VWDWLWLVFDQW GLIIHUHQFH ERWK JURXS DV UHJDUG WRWDO  
 7DEOH RPSDUDWLYH VWXG\ RI OLSLG SURILOH SDUDPHWHUV EHWZHHQ SDWLHQWV

	3DWLHQWV RQ GLDO\VLV	&RQWURO JURXS	S YDOXH
7* UDQJ 0 " 6'	"	"	
7& UDQJ 0 " 6'	"	"	
/'/ UDQJ 0 " 6'	"	"	
+ '/ UDQJ 0 " 6'	"	"	

**2WKHU DQDO\VLV**

ZDV " IRU SDWLHQWV RI JURXS  
 &RPSDUDWLYH OLSLG SURILOH SDUDPHWHUV EHWZHHQ JURXS DQG  
 JURXS ,, VKRZHG WKDW WKH PHDQ YDOXH RI WULJO\FHULGH OHYHO ZDV  
 " IRU JURXS , DQG " IRU JURXS ,, ZLWK RTDEORWK JURXS  
 D KLJKO\ VLJQLILFDQW VWDWLWLVFDQW GLIIHUHQFH EHWZHHQ ERWK JURXS  
 S 7DEOH DQG WKH PHDQ YDOXH RI WRWDO FKROHVWHURO  
 7DEOH RPSDUDWLYH VWXG\ RI OLSLG SURILOH SDUDPHWHUV EHWZHHQ SDWLHQWV RQ GLDO  
 JURXS LL

	*URXS , 37+ 1	*URXS ,, 37+! 1	S YDOXH
7* UDQJ 0 " 6'	"	"	
7& UDQJ 0 " 6'	"	"	
/'/ UDQJ	"	"	

- %LRO 7RGD\ V :RUOG

0 " 6'			
+ ' / UDQJ 0 " 6'	"	"	

7KH FRUUHODWLRQ EHWZHHQ 3DUDWK\URLG +RUPRQH OHYHO DQG RWKHU SDUDPHWHU VDELOH OLVDQG LQ

7DEORRUUHODWLRQ SDUDWK\URLG KRUPRQH OHYHO DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO

37+ ZLWK	*URXS , 37+ 1	
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'LDO\VLV GXUDWLRQ		

7DEORRUUHODWLRQ SDUDWK\URLG KRUPRQH OHYHO DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO LL

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'LDO\VLV GXUDWLRQ		

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& KURQLF UHQDO IDLOXUH LV DVVDFWLYH SDUDPHWHU DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO PRUELGLW\ DQG PRUWDOLW\ > @

: H GHVLJQHG WKL V WXG\ WR DVVDFWLYH SDUDPHWHU DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO 37+ DQG G\VOLSLGHPLD LQ KDHPRGLD DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO

)RU WKL V SXUSRVH SDWLHQWV R LQGLYLGXDOV QFOXGHG WKH\ ZHUH JURXS\ :H H[FOXGH VHFRQGDU\ FDYGLDEHWLF SDWLHQWV DV GLDEHWHV SDUDPHWHU DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO 7KH FODVVLFDWLRQ RI WKH SDWLHQWV DVVDFWLYH SDUDPHWHU DQG WULJO\FHULGH OHYHO OLSRSURWHLQ OHYHO DONDOLQH SKRVSKDWDVH OHYHO VHUXP FDOFLXP OHYHO @ ZKR VWXGLHG DQG FODVLI\ WKHP DFFRUGLQJ WR V

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, KDYH QRW VLJQHG DQ\ DJUHHERLDQW  
WKH UHVXOWV RI P\ UHVHDFK LQ DQV

LIMITATIONS

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, ZRXOG OLNH WR H[ SUHVV P\ VSHFLD  
WHDFKHU 6DEU\ \*RKU ZKR JDYH PH  
GR WKLV ZRQGHUIXO UHVHDFK RQ W  
K\SHUSDUDWK\URLGLVP DQG SUHPD  
KDHPRGLDO\VLV SDWLHQWV DW 0LQLD

CONCLUSION

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&XQQLQJKDP - /RFDWHOOL ) 5RGU  
+\SHUSDUDWK\URLGLVP 3DWKRJHQHVLV  
7KHUDSHXWLF 2SWLRQV &OLQ - \$P 6RF 1H  
(O .LVKDZL \$0 (O 1DKDV \$0 5HQDO 2VW  
WKH GLVHVDVH DQG LWV WUHDWPHQW 6DX

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\$KPD)GLLUMDIDKDWDPKD]DHL=SRXUMEDUQR  
1 5HODWLRQVKLS EHWZHHQ VHUXPOSSUQW  
SURILOH LQ QRQ GLDEHWLF K.DIGRHO  
7UDQVSO

)XNDJDZDD]DPD -- :LWK RU ZLWKRXX W  
)\*) LQ &1HSKURO 'LDO 7UDQVSO  
&RIDQ ) 9HOD ( &OHULHV 0 \$QDO\VLV  
RQFKURQLF KDHPRGLDO\VLV LQ &DWDORQ

LDL

DL

\$OPDGHQDQDOHMR \$ %DOOHVWHURV (  
(IIFW RI KLJK H[WUDFHOOXODU SKRVSKD  
DFLG SURGXFWLRQ E\ SDUDWK\URLG WLW

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\$NPDO 0 .DVLP 6( 6ROLPDQ \$5 0D  
SDUDWK\URLG KRUPRQH DGYHUVHO\ DIIH  
UHQDO IDLOXUH .LGQH\ ,QW ±  
\$WWPDQ 32 6DPXHOVVRQ 2 \$ODXSRYLF  
DQG UHQDO IDLOXUH \$P - .LGQH\ 'LV  
%DJGDGH -' <HH ( :LOVRQ ' 6KDIULU (  
IDLOXUWXGLHV RI SODVPD OLSRSURWH  
SURGXFWLRQ DQG WLVVXH OLSRSURWH  
PRGHO - /DE &OLQ 0HG ±  
%ODWRQ 9 '\VOLSLGHPLD DW FKURQLF

TRANSLATIONAL STATEMENT

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%ULFNHU 16 2Q WKH SDWKRJHQHVLV  
H[SRVLWLRQ RI WKH 3WUDGH RII K\SRWK

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'U•HNNH 7% +\SHUSDUDWK\URLGLVP VHF  
GLVHVDVH (XU - +RVS 3KDUP 3UDF  
&DPHOHMR 5 &DPHOHMR \$ 0RQHUR -  
)\*) IDLOV WR LQKLELW SDUDWK\URLG JC  
&RXWWHQ\H 003&'1+OHUWHKRUHQ :- %

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6FKURRWHQ 0( 'HR%LRRH WXUQRYHU LQ S  
IDLOXUH .LGQH\ ,QW ±

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%URZQ \$- =KRQJ 0 )LQFK - 5LWWHU &  
- HW DO 5DW FDOFLXP VHQVQLQJ UHFHVS  
QRW E\ FDOFLXP \$P - 3K\VLRO )  
)XNDJDZD 0 --D]DPDRNDZD . 5HQDO RV  
DQG VHFRRGDU\ K\SHUSDUDWK\URLGLVP  
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